NEVADA IRRIGATION DISTRICT
RAW WATER MASTER PLAN UPDATE: PHASE II

DECEMBER 2011

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J:\894\007\Docs\RWMP Phase 2 Sections\Final Sections - November 2011\001 NID Raw Water Master Plan Update Phase II Dec 2011.docx

ACRONYMS

APN	Assessor's Parcel Number
AWMP	Agricultural Water Management Plan
BMP	Best Management Practices
BR	Bear River System
CABY	Cosumnes, American, Bear and Yuba Rivers
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CFS	Cubic feet per second
CIP	Capital Improvement Program
CUWCC	California Urban Water Conservation Council
CWSRF	Clean Water Safe Revolving Fund
DC	Deer Creek System
DMM	Demand Management Measure
DWR	California Department of Water Resources
EA	Each
EIR	Environmental Impact Report
EL	Elevation
EWMP	Efficient Water Management Practices
FERC	Federal Energy Regulatory Commission
FT	Feet
GIS	Geographic Information System
GPCD	Gallons Per Capita Per Day
ID	Identification
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
LF	Linear Feet
MI	Miner's Inch
MSL	Mean Sea Level
NID	Nevada Irrigation District
PCWA	Placer County Water Agency

PEIR	Programmatic EIR
PG&E	Pacific Gas and Electric
PVC	Polyvinyl Chloride
R^2	Correlation Coefficient
RCO	Railroad Commission Order
RWMP	Raw Water Master Plan
RWSP	Regional Water Supply Project
SB	Senate Bill
SNOTEL	Snow Telemetry
SWRCB	California State Water Resources Control Board
TM	Technical Memorandum
UWMP	Urban Water Management Plan
UC	University of California

1.0 INTRODUCTION

The Nevada Irrigation District (NID or District) developed its first Raw Water Master Plan (RWMP) in 1985. In 2003, the District initiated this effort to update its RWMP, representing the first full and formal update to the original plan. This document presents the second and final phase of NID's updated RWMP. NID will adopt and act upon the results of this study and the recommendations presented herein after the plan receives approval from the District's Board of Directors, and an environmental impact analysis of the plan is completed in accordance with the California Environmental Quality Act (CEQA).

Phase I, which was completed in 2005, consisted of the technical analyses necessary to verify water supply, quantify expected future demand, and evaluate the adequacy of the existing water conveyance system to accommodate current and future demand. Phase II, which is the subject of this report, consists of an update to the demand analysis presented in Phase I, and identification of capital improvement projects required to meet future demand for water within the NID service area. This document is a companion piece that supports and builds upon results reported in Phase I. Some material from the Phase I report is repeated and/or summarized here for purposes of clarity. For a comprehensive view of the work scope completed to update the RWMP, readers are encouraged to review the Phase I report.

1.1 REVIEW OF THE PHASE I RWMP

The Phase I technical analysis provided the following:

- an overview of the NID conveyance system and described the water supply and delivery including water sources and storage; NID's water rights; and NID's water deliveries (Phase I Sections 3.0 and 4.0);
- the estimated consumptive water demand within the District's service area for the period 2002 through 2027 by season (irrigation season and winter season) using 2002 as the base year, and a description of the analysis used, data inputs, assumptions, and constraints, as well as the electronic model developed in Microsoft Excel (Phase I Section 5.0);
- a comparison of water supply with the estimated demand and an examination of the system to determine whether the system is of adequate size and condition to accommodate projected demand (Phase I Sections 6.0 and 7.0);
- a review of the District's policies and regulations for consistency with California's 1994 Water Plan Update (Phase I Section 8.0);

- general recommendations for capital improvements to support the District's ability to meet estimated demand and continue servicing its customers into the future (Phase I Section 9.0);
- a discussion of environmental issues that must be considered in NID's operations and near and long-term capital projects (Phase I Section 10.0); and
- a review of NID's operations to identify potential actions that would enhance the cost-effective and reliable delivery of water to its customer base (Phase I, section 11.0).

1.2 OVERVIEW OF PHASE II RWMP

Phase II of the new RWMP was originally intended to provide the detailed capital improvement plan (CIP) based on the results of Phase I. However, this phase was expanded, and now includes the following items:

- Conversion of demand model to a Microsoft Access platform
- Updated demand projections through 2032
- Review of NID's water supply
- Updated review of NID's policies and regulations
- Capital Improvement Plan

Section 2.0 presents study goals and objectives for updating the RWMP, and Section 3.0 provides an overview of NID's water conveyance system. Section 4.0 describes the model developed to estimate future water demand for NID's service area, explains how the model was updated from Phase I efforts, and presents the resulting estimated demand. Section 5.0 consists of an assessment of the District's water supply and demand, including water deliveries, reservoir impacts and water shortages. Section 6.0 address water management within the District and discusses the potential impacts of climate change, sustainability, and drought contingency planning. Section 7.0 is an analysis of District policies and regulations and provides recommendations to ensure compliance with the 2009 California Water Plan. The Capital Improvement Plan makes up Section 8.0, addressing existing conveyance conditions and capacity, and recommending a plan to direct infrastructure improvements that will ensure system infrastructure will be able to meet future demand.

A companion piece to this report is an electronic copy of the demand model in its new operating platform – Microsoft Access. The demand model created in Phase I consisted of a spreadsheet model using Microsoft Excel. While effective for the Phase I effort, it had some shortcomings.

For example, it required extensive manipulations of the customer and flow data prior to input into the model. Moreover, the model was limited to the 5-year increment calculation interval as requested for the Phase I effort.

For the Phase II effort, the model platform was converted from Microsoft Excel to a Microsoft Access (Access) database, which is relational database software that is compatible with Geographic Information Systems (GIS) technology. This approach has several advantages for the District, the first being that the model allows for direct integration with the District's customer data, resulting in the ability to update, verify, or adjust model inputs, and/or review various scenarios for both current and future planning. Secondly, having the demand model in-house allows the District to assess impacts on demand for a single canal segment or for the District as a whole. Thirdly, the base data used in this analysis was developed using GIS technology with an integrated Access database platform. Finally, the model has been constructed to allow greater flexibility to users. All input variables can be easily edited, including loss rate, growth rate, estimate of conservation measures, and period of forecast. This allows the user to perform sensitivity assessments on a particular canal segment, canal subsystem, Deer Creek or Bear River system, or the District as a whole. Further, results are displayed graphically or in tabular form using one of several standardized forms available within the database.

2.0 GOALS AND OBJECTIVES

Prior to initiating the RWMP work, the District developed goals and objectives that would direct the technical work necessary for the update. In the spring of 2003, NID hosted a series of internal meetings followed by a series of public outreach meetings to develop and refine the goals and objectives.

2.1 GOALS

The goals are stated below. Goals 1 through 4 relate directly to the RWMP update, and the issues it addresses. Goals 5 through 7 identify managerial issues that the RWMP should assist the District in addressing.

1. Update the 1985 Raw Water Master Plan.
2. Quantify long-term water demands and available long-term water supplies, including drought year provisions.
3. Recommend improvements for expansion, maintenance, and operation of raw water infrastructure.
4. Provide guidelines for future raw water system policies, operations and improvements.
5. Meet the District's long-term water service obligations, pursuant to State Water Code Division 11.
6. Maximize use of available water.
7. Minimize significant effects to environmental and cultural resources.

2.2 OBJECTIVES

In addition to the goals listed above, NID and the public expressed an interest in ensuring that the RWMP address specific tactical issues. Based on these concerns a set of objectives were developed, of which four relate directly to the updated RWMP (objectives 3, 5, 8, and 15). In turn, the new RWMP will aid the District in its decision-making to address the remaining objectives. These objectives are intended to promote a proactive approach to addressing the expected growth in water demand which will result in an effective and efficient use of the District's resources. The agreed-upon objectives for the RWMP were developed during the Phase I effort and are restated below.

1. Respond adequately to current and future water demands while maximizing all reasonable and beneficial uses of NID's water supply system.
2. Meet future water demands resulting from county and city planning processes.
3. Improve dependability, reliability, and flexibility of the water conveyance system.
4. Protect and enhance raw water quality and raw water supply.
5. Identify critical raw water infrastructure capital improvement needs and timing.
6. Reduce water losses in the water conveyance system.
7. Enhance system operations for District operators and customers.
8. Facilitate District policy decisions and rule making process, and forecast future needs of District.
9. Facilitate public awareness and involvement.
10. Identify broad-scale environmental factors associated with potential capital improvements.
11. Avoid deferred maintenance.
12. Avoid water service moratoriums.
13. Identify financial needs and timing.
14. Investigate hydroelectric power generation opportunities.
15. Create a document that is user-friendly and agency-friendly.

3.0 OVERVIEW OF THE NID CONVEYANCE SYSTEM

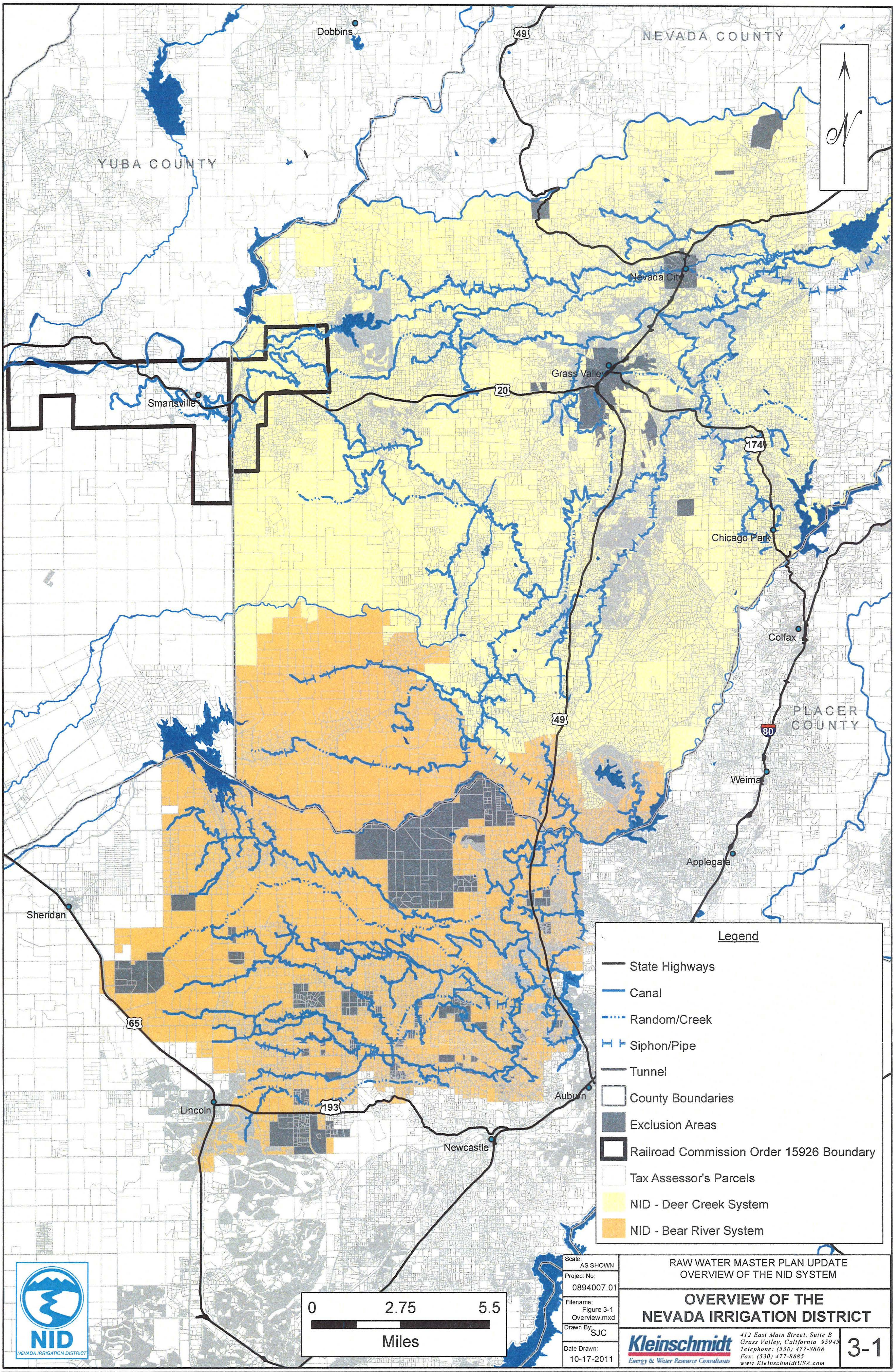
The Nevada Irrigation District was established in 1921 under the California Irrigation District Act of 1897. The District operates as a nonprofit water agency under Division 11 of the State Water Code. The District services approximately 287,000 acres in Placer, Nevada, and Yuba counties in Northern California, supplying both treated and raw water for irrigation, municipal, domestic, and institutional purposes (Figure 3-1). While seasonally dependent, in recent years, NID has an average combined annual total demand (treated and raw) of approximately 165,000 acre-feet of water.

The District's water supplies are derived principally from the Yuba River, Bear River, and Deer Creek watersheds. In the early 1920s, NID acquired storage and regulating facilities in the upper reaches of the Middle and South Yuba Rivers. In 1926, NID acquired most of its Canyon Creek holdings including the Bowman, Sawmill, French, and Faucherie Reservoirs. Associated water rights were also obtained. Deer Creek rights were obtained in the 1920s for the development of Scott's Flat Reservoir. In 1963, NID partnered with Pacific Gas & Electric (PG&E) to develop additional storage and conveyance capacity and generate power from water derived from the Yuba and Bear River watersheds through the Yuba-Bear Project.

Today, NID operates and maintains a total of 10 water supply reservoirs (Figure 3-2). In addition to these reservoirs, the District maintains a delivery network of approximately 425 miles of mostly open canals. There are two major distribution and storage systems within the NID system: Deer Creek and Bear River (Figure 3-3 and 3-4). These systems are comprised of a mixture of canals, siphons, pipelines, and other water conveyance structures, as well as reservoirs and water treatment plants. The conveyance structures, reservoirs, and treatment plants contained within each of these systems are identified in Table 3-1 and Table 3-2 for the Deer Creek and Bear River systems, respectively.

Water is provided to the District by four sources: water coming from the watershed, carry-over storage, contract purchases, and recycled water. The sum total of these sources provides NID with approximately 330,000 acre-feet of water annually. This value varies from year to year based upon the hydrologic conditions of the watershed and District lands. The District has water rights to approximately 450,000 acre-feet of water when available.

Current District-wide raw water deliveries serve approximately 5,400 agricultural and municipal customers. Most customers purchase their water seasonally, from April through October. Approximately 90 percent of seasonal water purchases are used for agricultural applications, such as irrigation of pastureland and family gardens, and the remainder for either raw water to be treated and used for drinking or non-potable household uses. NID began providing treated potable water in the late 1950s. The first conventional water treatment plant was constructed in 1963 to serve the Forest Knolls subdivision. As of 2009, NID operated seven water treatment plants serving over 18,000 connections.



NEVADA COUNTY
YUBA COUNTY
PLACER COUNTY
N
Dobbins
Nevada City
Grass Valley
Smartsville
Chicago Park
Colfax
Weimar
Applegate
Sheridan
Lincoln
Auburn
Newcastle
49
20
174
80
65
193
Legend
State Highways
Canal
Random/Creek
Siphon/Pipe
Tunnel
County Boundaries
Exclusion Areas
Railroad Commission Order 15926 Boundary
Tax Assessor's Parcels
NID - Deer Creek System
NID - Bear River System
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Miles
NID
NEVADA IRRIGATION DISTRICT
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Drawn By: SJC
Date Drawn: 10-17-2011
RAW WATER MASTER PLAN UPDATE
OVERVIEW OF THE NID SYSTEM
OVERVIEW OF THE
NEVADA IRRIGATION DISTRICT
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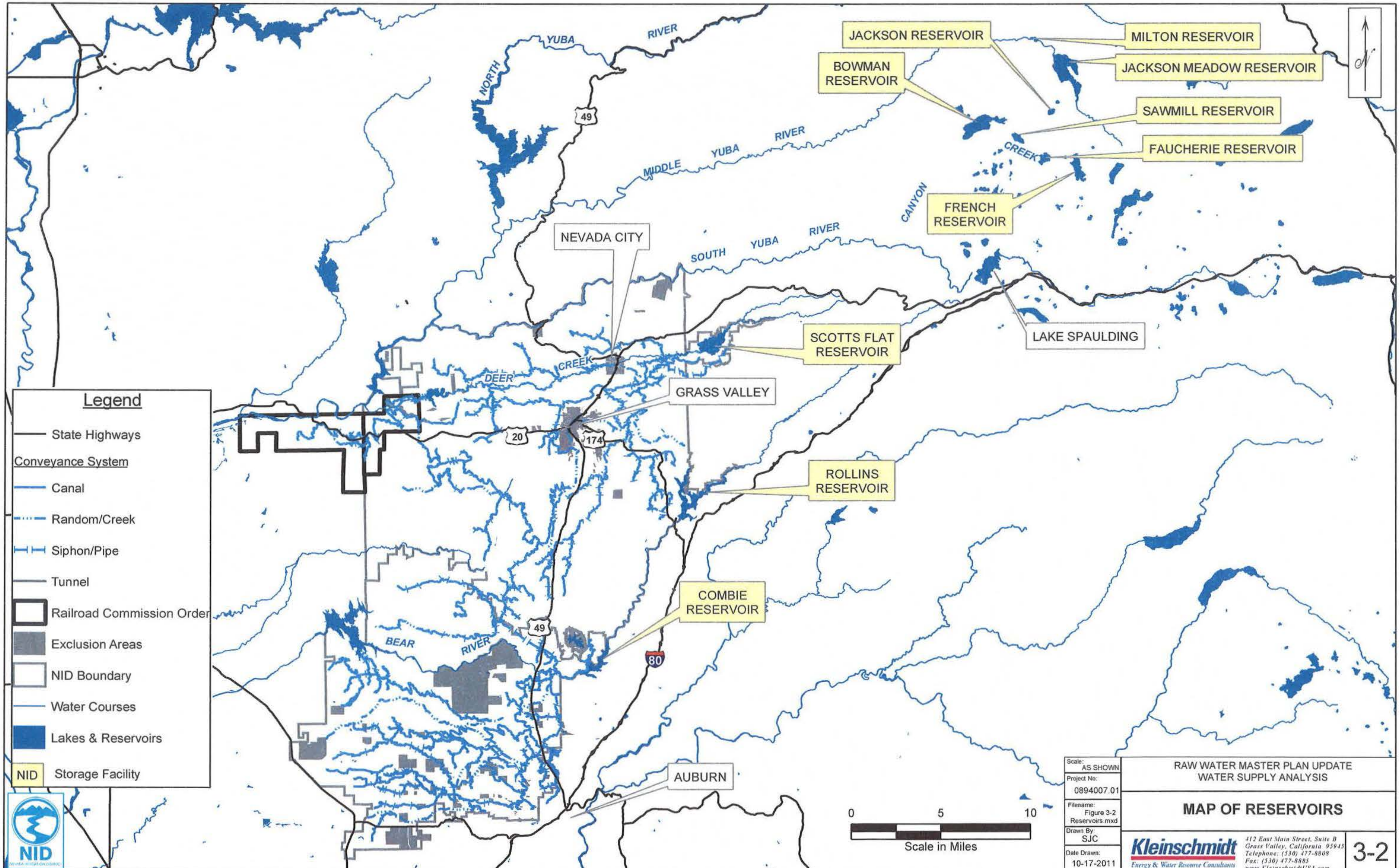

YUBA RIVER
NORTH
MIDDLE YUBA RIVER
SOUTH YUBA RIVER
CANYON CREEK
DEER CREEK
BEAR RIVER
49
20
174
80
JACKSON RESERVOIR
MILTON RESERVOIR
BOWMAN RESERVOIR
JACKSON MEADOW RESERVOIR
SAWMILL RESERVOIR
FAUCHERIE RESERVOIR
FRENCH RESERVOIR
NEVADA CITY
LAKE SPAULDING
SCOTTS FLAT RESERVOIR
GRASS VALLEY
ROLLINS RESERVOIR
COMBIE RESERVOIR
AUBURN
Legend
State Highways
Conveyance System
Canal
Random/Creek
Siphon/Pipe
Tunnel
Railroad Commission Order
Exclusion Areas
NID Boundary
Water Courses
Lakes & Reservoirs
NID Storage Facility
NID
0 5 10
Scale in Miles
Scale: AS SHOWN
Project No: 0894007.01
Filename: Figure 3-2 Reservoirs.mxd
Drawn By: SJC
Date Drawn: 10-17-2011
RAW WATER MASTER PLAN UPDATE
WATER SUPPLY ANALYSIS
MAP OF RESERVOIRS
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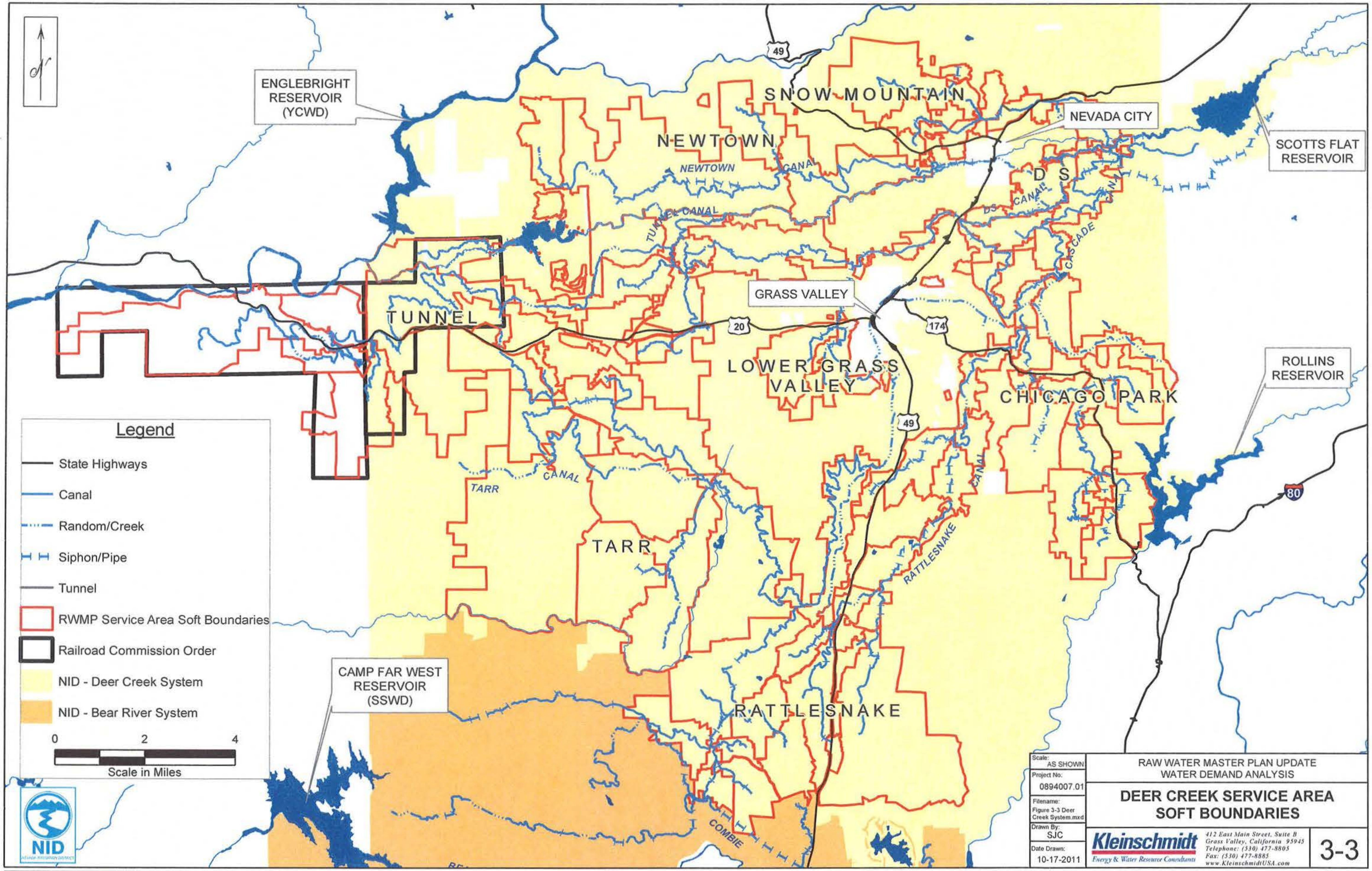
ENGLEBRIGHT RESERVOIR (YCWD)
SNOW MOUNTAIN
NEVADA CITY
SCOTTS FLAT RESERVOIR
NEWTOWN
NEWTOWN CANAL
D S
DS CANAL
CASCADE CANAL
TUNNEL CANAL
TUNNEL
GRASS VALLEY
20
174
49
LOWER GRASS VALLEY
CHICAGO PARK
ROLLINS RESERVOIR
TARR CANAL
TARR
RATTLESNAKE CANAL
RATTLESNAKE
80
CAMP FAR WEST RESERVOIR (SSWD)
COMBIE
Legend
State Highways
Canal
Random/Creek
Siphon/Pipe
Tunnel
RWMP Service Area Soft Boundaries
Railroad Commission Order
NID - Deer Creek System
NID - Bear River System
0 2 4
Scale in Miles
NID
Scale: AS SHOWN
Project No: 0894007.01
Filename: Figure 3-3 Deer Creek System.mxd
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Date Drawn: 10-17-2011
RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS
DEER CREEK SERVICE AREA
SOFT BOUNDARIES
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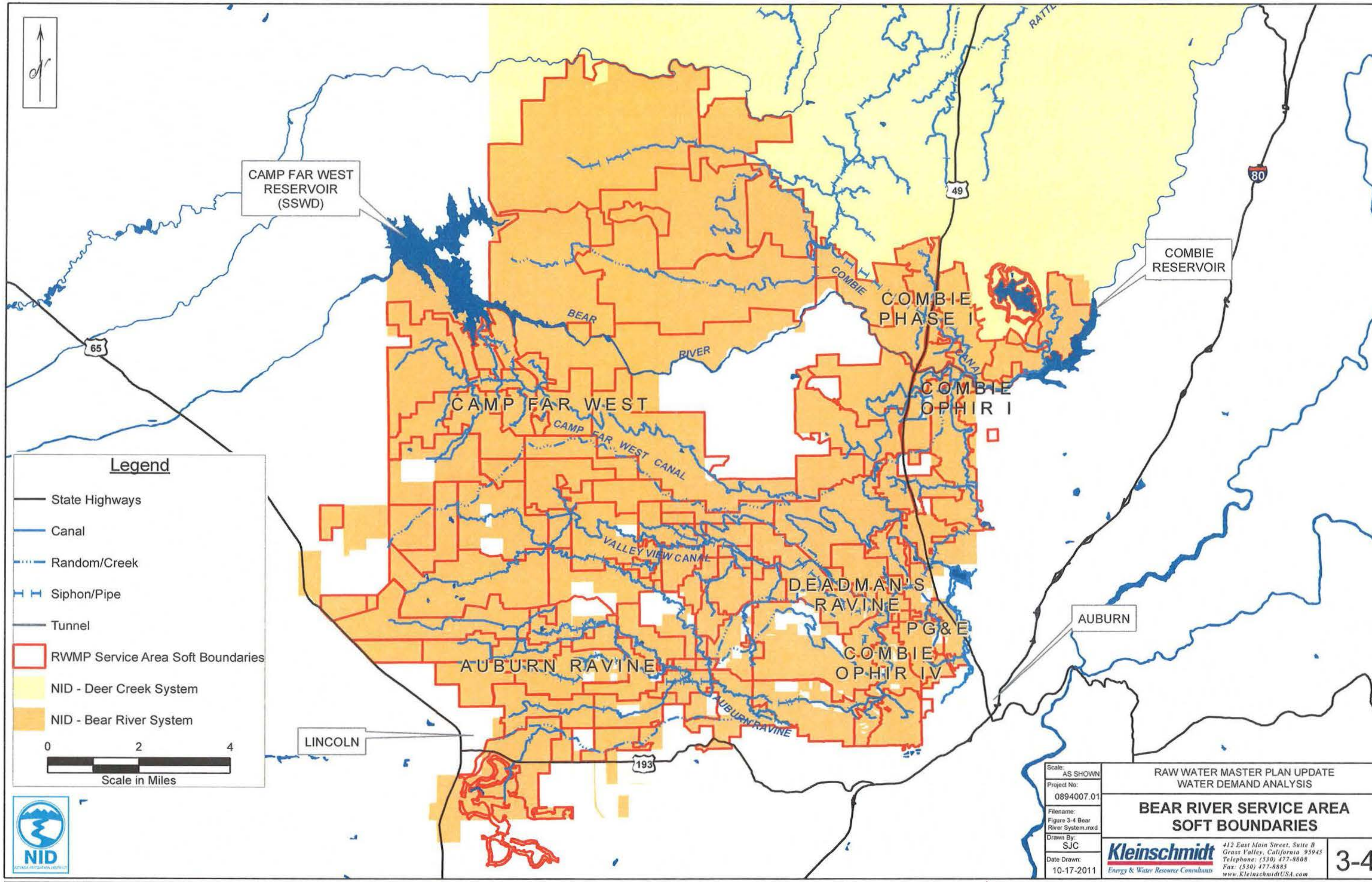
CAMP FAR WEST RESERVOIR (SSWD)
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LINCOLN
65
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80
193
BEAR RIVER
COMBIE
COMBIE PHASE I
COMBIE OPHIR I
CAMP FAR WEST
CAMP FAR WEST CANAL
VALLEY VIEW CANAL
DEADMAN'S RAVINE
PG&E
COMBIE OPHIR IV
AUBURN RAVINE
Legend
State Highways
Canal
Random/Creek
Siphon/Pipe
Tunnel
RWMP Service Area Soft Boundaries
NID - Deer Creek System
NID - Bear River System
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Scale in Miles
NID
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RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS
BEAR RIVER SERVICE AREA SOFT BOUNDARIES
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TABLE 3-1. DEER CREEK SYSTEM CANALS AND FACILITIES

Cascade Canal
Cascade Shores Treatment Plant

Snow Mountain Canal
Willow Valley Canal
Cement Hill Canal
Lake Vera Pipe
Sugarloaf Reservoir and Pipe
Red Hill Canal
Red Hill Reservoir and Pipe
Buffington Canal

Upper Grass Valley Canal
Elizabeth George Treatment Plant

Loma Rica Reservoir
Loma Rica Treatment Plant

Chicago Park Canal
O'Leary Pipe
Sunshine Valley Canal
Sontag Canal
Ripkin Canal
Ruess Reservoir
Chicago Park East Canal
Chicago Park Pipe
Chicago Park West Canal
Meyer-Bierwagen Pipe
Blum Pipe
Smith Moulton Reservoir and Pipe
John Henry Meyers Canal

Rattlesnake Canal
Woodpecker Canal
Forest Springs Canal
Maben Canal
Kyler Canal
Maben Reservoir and Pipe
Cunningham Reservoir
Grove Canal
Cherry Creek Canal

Scotts Flat Reservoir

Lower Scotts Flat Reservoir

DS Canal

Red Dog Canal

Lower Grass Valley Canal
Alta Hill Reservoir

Allison Ranch Canal
Corey Canal
Lafayette Canal

Rough and Ready Canal
Sazarac Canal
Rough & Ready Reservoir

Tarr Canal
Breckenridge Canal
Clear Creek Canal
Beyers Canal
Smith Gordon Canal
Casey Loney Canal
Stinson Pipe
Pet Hill Canal
Pet Hill Canal Extension
Bald Hill Canal

B Canal
Cole Viet Canal
Miller Canal
Wolf Canal
Pearl Barnes Canal
Carpenter Canal
Cole Canal

Newtown Canal
Newtown Reservoir
Lester Canal
Lake Wildwood Treatment Plant

Tunnel Canal
Riffle Box Canal
Tunnel Canal Extension
Rex Canal
Portuguese Canal
Rex Reservoir
Quincy Canal
Quincy Pipe

China/Union Canal
Spenceville Canal
Meade Canal
Union Reservoir
Ousley Bar Canal
Town Canal
Smartsville Treatment Plant
Farm Canal

Keystone Canal

TABLE 3-2. BEAR RIVER SYSTEM CANALS AND FACILITIES

Combie Reservoir

Combie Phase I Canal

Magnolia III Canal
Magnolia III Reservoir
Magnolia III Canal Extension
Lake of the Pines Treatment Plant

Combie Phase II & III Canal
Magnolia I Canal
Weeks Canal
Magnolia II South Canal
Magnolia II North Canal
Markwell Canal
Wolf Hannaman Canal
Sanford Struckman Canal

Combie Ophir I Canal
Lone Star Canal
Ruud Canal
Rainey Canals
Oest Canal
Willits Canal

Orr/Coon Creek Natural
Orr Creek Reservoir
Gold Hill I

Camp Far West Canal
Lateral 5 Canal
Lateral 4 Canal
Lateral 2 Canal
Lateral 1 Canal
Wiswell Gladding Canal
Church Canal
Forbes Canal
Renken Lateral
Bogdanoff Canal
Camp Far West Canal Extension

Combie Ophir II Canal
Pickett Canal
Beck Canal
Pickett Reservoir
Pickett North Canal
Pickett South Canal
North Auburn Treatment Plant
Rock Creek/Gold Hill I Bypass Canal

Combie Ophir III Canal
Columbia East
Columbia West

Combie Ophir IV Canal
Vernon Canal
Rohr-Shanley Pipe
Herkomer Pipe
Dudley Canal
Gold Blossom Canal
St. Patrick's Canal
Little Ophir Canal
Hymas Canal

Gold Hill II Canal
Deadman's Ravine Natural
Whiskey Diggins Canal
Old Whiskey Diggins Canal
Valley View Canal
Files Canal
Valley View Reservoir
Kilaga Springs Canal
Nicklas Canal
Livingston Canal
Reilli Canal
Iron Canyon Canal
Thomas Canal
Stringham Canal

Ophir Canal
Kemper Canal
Kemper East Canal
Kemper West Canal
Bean Cullers Canal

Edgewood Canal
Edgewood Reservoir
Edgewood Canal

Auburn Ravine Canal I
Chevalier Pipe
Auburn Ravine Canal II
Lincoln Canal
Musser Canal
Markell Canal
Fruitvale Canal
Sohier Ahart Canal
Hayt Canal Extension
Doty Canal
Doty South Canal
Doty North Canal
Comstock Gladding Canal
Clark Jorstad

Hemphill Canal

4.0 WATER DEMAND ANALYSIS

An integral part of Phase II consisted of updating the raw water demand model developed as part of Phase I. This update allowed for a check and adjustment of the methods and assumptions used in the Phase I work. Further, since Phase I was published, five years of additional data from system flows and the District's customer billing database have become available and were incorporated into the model inputs.

The Phase II work used the same approach in estimating District demand as was employed in Phase I. Details regarding the overall approach to estimating water demand is provided in Section 5.0 of the Phase I report. Modifications to the model design and inputs are presented here, followed by a summary review of the model structure, and finally, results of these analyses.

4.1 DATA UPDATES

Data inputs and modeling criteria were modified in Phase II to update the model's base year from 2002 to 2007. The data on which the updated model is based incorporates information from the District's customer service records showing water sold from 2002 through 2007; new or proposed developments within the District's service area; updated data from crop reports and canal gages; and updated assessors' parcel maps. Using the new information, soft service area boundaries were revised and updated. The assumptions used in this analysis were tested and revised where necessary. To confirm the applicability of the assumptions and methods, the model was calibrated to the year 2007, the most recent year of complete data when the modeling effort was begun.

In consultation with the District, the following data sources were incorporated into the updated demand analysis.

Data provided by the District:

- Customer information (2002–2007) from customer billing data, including service ID, county parcel number, service size and service type.
- Historical water treatment plant flow records and District's Urban Water Master Plan.
- Mutual water company and association updates.

- Canal flows (in cfs) (2002–2007) from the gaging network for the Deer Creek and Bear River systems.
- Crop report data (2002–2007) including service connections in miner's inches and net acres of irrigated cropland by crop type.

Data provided by Nevada, Placer, and Yuba Counties:

- Assessors' parcel data from Nevada and Placer Counties (2007), and Yuba County (2006).

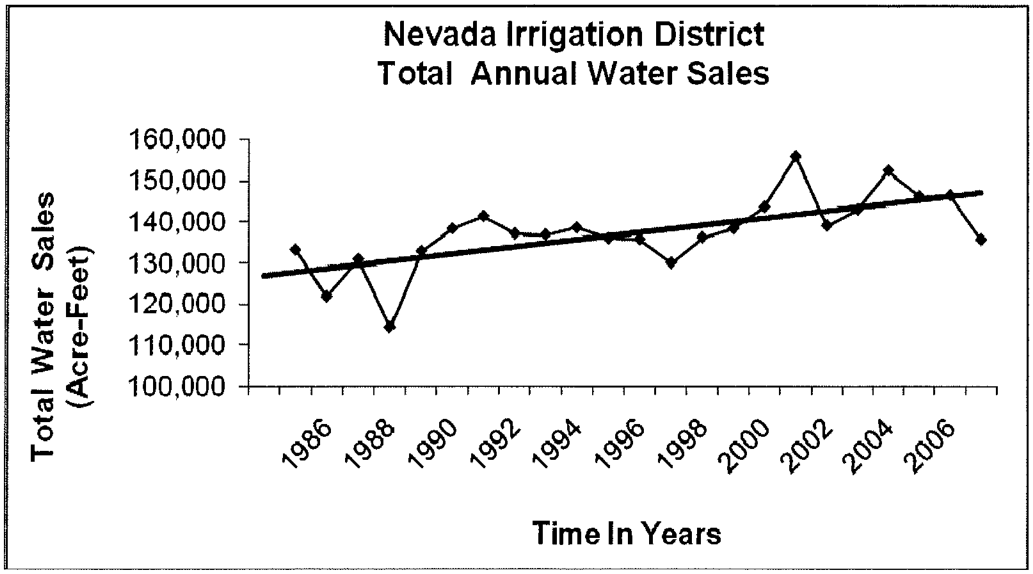
4.1.1 Customer Information – Raw Water

The 2007 raw water customer data provided by the District consisted of physical and billing address, location of service (assessor's parcel number), account status, service size, unit of flow measure, service box number, and service type (seasonal, annual, intermittent flows, etc.). The customer data were used to determine the total acres receiving water for each respective canal segment.

The District also provided its annual Water Recap Reports for the years 1985–2007. These reports summarized in acre-feet the raw water customer sales for the Deer Creek system, the Bear River system, and the total District. They also provide the number of raw and treated services. Total sales for the District for the period 1985–2007 are illustrated in Figure 4-1. Total water sales, while a good indicator of the trend in demand, only represent net demand as the noted values do not include system losses.

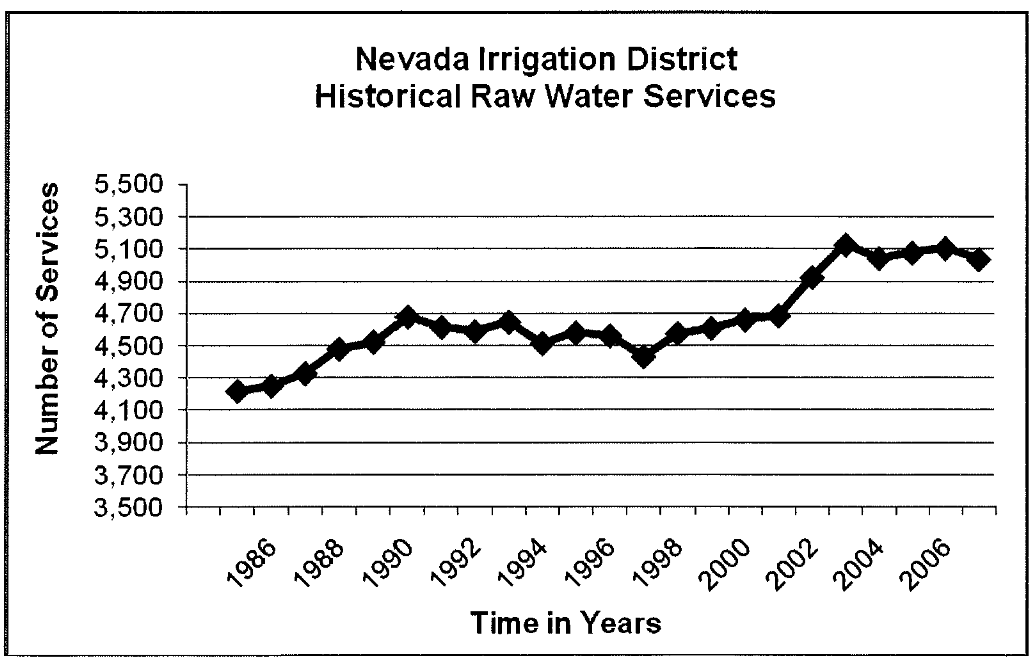
Total water sales figures vary greatly from year to year, as should be expected, due to the variation in hydrologic conditions for any given year. A hot, dry irrigation season may have a high value, while a cool, wet spring would result in a lower value. Supplemental sales can also result in a large variation in total sales figures. Despite the annual variation shown in Figure 4-1, a trend analysis of the data shows a steady increase in water sales. The trend line shows that for the period 1985–2007, water sales increased at a rate of approximately 1,000 acre-feet per year.

FIGURE 4-1. TOTAL ANNUAL WATER SALES



The annual Water Recap Report also provides the number of raw and treated services. Figure 4-2 plots total raw water services for the period 1985–2007. The graph shows a substantial increase in services during two specific periods: the late 1980s and the period 2000–2002. Since then, however, growth in raw water services has been relatively flat.

FIGURE 4-2. HISTORICAL RAW WATER SERVICES



While overall growth in raw water services has been minimal during the mid-2000s, based on the crop report data for the period 2003–2007, the number of seasonal services has increased during the period. Inactive services also increased during this period, while the number of annual services has declined.

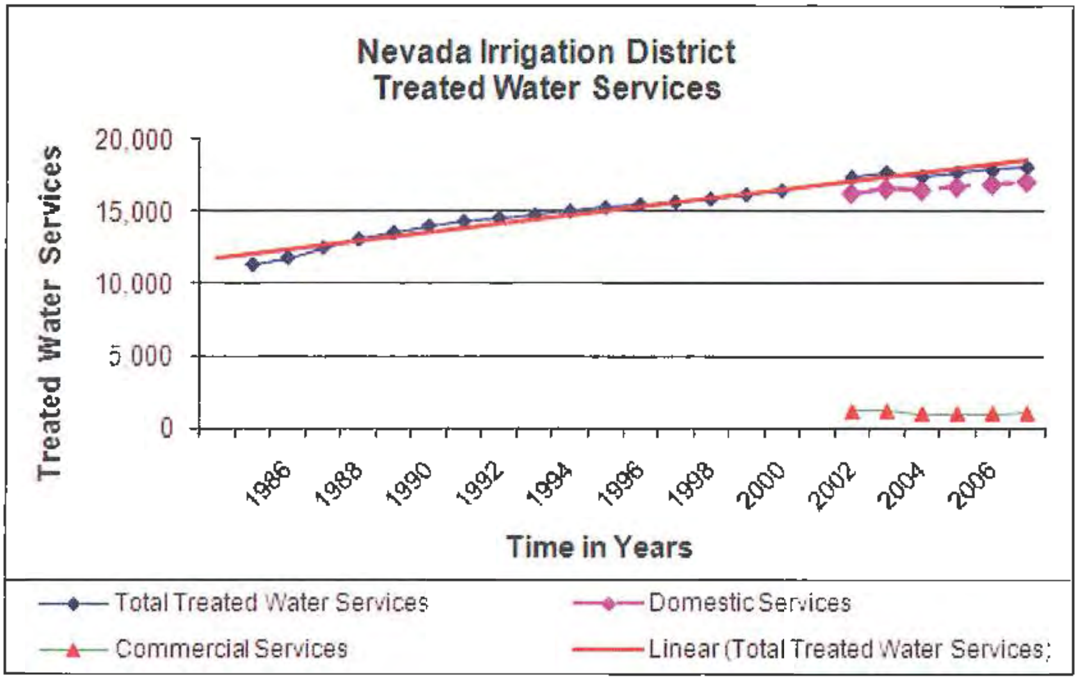
Based on the requests for water evident from the mutual water companies, there are indications that there will be substantial increases in raw water demand as delivery capacity is increased in the future.

4.1.2 Customer Information – Treated Water

The 2007 treated water customer data provided by the District were comprised of physical and billing address, location of service (assessor's parcel number), meter ID, consumption, and service facility. The treated water customer data were used to determine the total acres receiving water.

Figure 4-3 illustrates the historical growth in treated water services within the District as reported in the Water Recap Reports. As shown, treated water services/connections have steadily increased over the past 22 years. In 1985, there were 11,380 treated water services reported. By 2007, this number increased—to 18,815—with the majority of these consisting of all services minus fire services (17,068 services). The growth trend in the number of treated water services is expected to continue through the planning horizon (2008–2032).

FIGURE 4-3. HISTORICAL TREATED WATER SERVICES



The 2005 Urban Water Management Plan (UWMP) projected that the growth in treated water services would increase at an annual rate of approximately 4 percent over a 10-year period (1995–2005). Based on this projection, the number of service connections would more than double by 2025 to a projected 41,084 connections. Based on the District's data for the period, however, this projected growth trend did not materialize. From 2000 to 2007, treated water connections increased from 16,482 connections to 18,092 connections. From the trend line shown in Figure 4-3, the growth in treated water services has been relatively constant, at a rate of approximately 1.2 percent. Recent data published in the District's 2010 Urban Water Management Plan (Brown and Caldwell, 2011: pg 3-5, Section 3.3.1) notes an annual growth rate of 0.7 percent, which is consistent with the historic projections.

4.1.3 WATER TREATMENT PLANT DATA

Existing and predicted future treated water demand data for the District and non-District water treatment plants were provided by the District. Flows to the water treatment plants are documented on a daily basis, in terms of both daily peak flow and total flow volume. For the treated water growth projections occurring within the Nevada County portion of the District's boundaries, the District used build-out projections based on the County's General Plan policies and modeled using GIS (developed by Facet Decision Systems) to provide mapped forecasts of residential and commercial growth in 5-year increments to the year 2027 (Table 4-1). (Values used in the model for intervening years were obtained by interpolation of the data.)

In Placer and Yuba counties, the projected water treatment plant demands were based on the predicted growth noted in the respective General Plans. For the Phase II work, NID recommended using the same growth projections for future treatment plant demand as was used in the Phase I analysis. The District also provided daily maximum flow data for its plants for the period 2003–2007.

TABLE 4-1. TREATMENT PLANT ACTUAL AND PROJECTED PEAK FLOW

FACILITY	SYSTEM	MAXIMUM DAILY FLOW (CFS) (2007)	PROJECTED PEAK FLOW (CFS) BY YEAR					
			2012	2016	2020	2024	2028	2032[2]
E. George	Deer Creek	16.3	22.7	26.7	29.6	31.3	31.5	31.5
Loma Rica	Deer Creek	11.4	12.4	13.6	15.0	16.0	15.7	15.7
Lake Wildwood	Deer Creek	7.2	8.2	9.1	10.3	11.7	13.3	15.5
Smartsville	Deer Creek	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lake of the Pines	Bear River	6.0	6.6	7.1	7.7	8.4	9.0	9.8
North Auburn	Bear River	7.4	8.8	9.9	10.8	11.5	12.0	12.4
Nevada City[1]	Deer Creek	1.8	2.2	2.5	3.0	3.5	4.0	4.7
Grass Valley[1]	Deer Creek	3.5	4.0	4.6	5.1	5.8	6.6	7.4
Total Flow		53.7	65.0	73.6	81.6	88.3	92.2	97.1

[1] Not a Nevada Irrigation District facility; however, raw water is supplied by the District.[2] Some of the projected peak flows in 2027 and 2032 exceed the projected plant capacities noted in the District's 2010 UWMP. These demands should be evaluated for concurrence.

Development of the Regional Water Supply Project (RWSP) in Lincoln has advanced since completion of the Phase I effort. As such, a water demand allowance for the facility is included in the Phase II work. Estimated demand for the proposed RWSP was coordinated with the

District and its consultants for the project, ECO:LOGIC[1]. The current conceptual plan is for the facility to come on-line in three phases, however, there is currently no definitive start date for the RWSP and a number of alternatives are being considered. For planning purposes, it is assumed that the first phase of the project will be online in 2015. The resulting initial demands are included in this analysis. Because the exact routing of the water supply to the facility is not known at this time, the project's estimated demand is included as a line item in the demand model at the head of the Combie system. More information and analysis regarding the RWSP is provided in Appendix B.

4.1.4 Canal Gages

The District operates a network of approximately 165 gages from which it records daily flow data. NID Operations regularly monitors and calibrates the gages to maintain overall accuracy within +/- 5 percent of the true value. For the Phase II update to the demand model, daily flow data for the period of 2002–2007 were obtained from the District and added to the flow database developed in Phase 1 (1992–2001). For the computation of future demand, it is necessary to establish the longest representative common period of record for application of the flow data. Based on the gage data provided by the District, some gages were added (in or about 2002), while others were terminated (no flow records past 2002). Flows can, and do, vary from year to year, as well as during the course of the irrigation season. For this reason, the duty rate (average flow of raw water per acre delivered during the irrigation season) used in the demand forecast was computed using average flow values from the longest common period of record for all gages. For the Phase II work, the average period used was 2002–2007, inclusive.

[1] ECO:LOGIC has since merged with Stantec.

Gage data were also used to assess trends in regards to water usage. Flow data that are trending upward or downward will skew the accuracy of the demand values. For example, using an *average* flow for a gage that is trending downward will provide an *overestimate* of future demand. Therefore, a trend analysis was performed for each gage to ensure that the average gage value was applicable.

Gage data were also used for model calibration. The Phase II model used the flow data from 2007 as the calibration year in conjunction with the 2007 customer data records, the most recent year of data available when modeling was begun.

The final use of the gage data was to derive the peak to average flow ratios, which were used to estimate the future peak flow for each canal segment. This value was computed by dividing the daily peak value by the irrigation season average for the same year. The average of the annual peak to average flow ratio for the period 2002–2007 was then used to estimate future peak flow values.

4.1.5 MUTUAL WATER COMPANIES AND WATER ASSOCIATIONS

The creation of mutual water companies and/or mutual water associations (mutuals) impacts overall water demand in two ways. The first is the localized "immediate" impact resulting from the concentrated increase in demand. The second effect is increased stress to the system infrastructure, which needs to deliver the rapidly increasing flow demand.

The projected demand of the mutuals was accounted for by increasing the growth rates for the affected canal segments for the period anticipated for formation of the mutuals (2008–2016) to reflect the anticipated growth. For example, the South Nevada County Mutual Water Company, located on the Grove Canal, is anticipated to increase demand on the Grove Canal 160 miner's inches (MI) over the next 5 to 10 years. Other mutuals with similar growth potential include Lake of the Pines Ranchos and Melody Oaks (approximate total of 160 MI). Several smaller mutuals will see a potential increase in demand of up to 10 MI. The impact from these smaller mutuals, however, was determined to be within the anticipated service area's growth projection, and no special additional adjustments were made to the model to reflect the additional demand.

In Phase I, 36 active mutuals (2001 data) were reported, with 3 additional mutuals proposed. Currently, 40 mutuals are reported as active or developing. Table 4-2 summarizes the status of mutuals within the District, the amount of change from Phase I, and the forecasted demand. The total demand in Phase I for the 36 active mutuals was 744 miner's inches. The 2008 mutuals demand was computed to be 797 miner's inches, an increase of approximately 9 percent. Using the demand predictions for the mutuals reported by the District, the anticipated demand by the mutuals in 2016 could be as high as 1,121 miner's inches, a 41 percent increase from the current value. Assuming the proposed full build-out of the listed mutuals occurs by 2016, the resulting additional summer flow demand in 2016 will be approximately 2,900 acre-feet. The two mutuals highlighted in Table 4-2 have a combined anticipated demand over the next 5 to 10 years of up to 300 miner's inches, or 7.5 cfs. These two mutuals alone represent a potential demand of 2,722 acre-feet.

TABLE 4-2. SUMMARY OF MUTUAL WATER COMPANIES FOR 2008

MUTUAL WATER COMPANY	NUMBER OF PARCELS	ACREAGE	PHASE I (M.I.)	2008 (M.I.)	CHANGE	ANTICIPATED FUTURE GROWTH
6 B Estates Water Association	22	119.8	20	20	0	Not much growth expected. Will likely hold steady.
Ali Lane Mutual Water Association	11	31.8	8	7	–1	Not much growth expected. Limited by capacity of pump station.
Big Oak Valley Mutual Water	13	131.3	42	24	–18	Legal issues are limiting current demand. Problems will likely work out and demand will return to historic levels.
Blackford Ranch Water Association	52	248.2	30	28	–2	System needs some work. Increase expected. Up to a total of 40 MI in approximately 10 years.
Carmody Sp Water District Company	8	135.5	10	10	0	Some potential for growth. Melody Oaks may take some demand away.
Chicago Park Water Association	8	38.5	27	27	0	Near capacity.
Chili Hill Farms Water Association	10	57.4	21	21	0	Growth of several inches possible.
Clear Creek Water Association	3	24.1	11	11	0	Not much growth expected. Will likely hold steady.
Cole Country Water Users Association	24	269.7	36	38	2	Some potential for growth.
Countryside Ranch Water Association	20	254.6	21.5	22.5	1	Has growth potential.
Fawn Hill Drive Water Association	18	102.3	4.5	4.5	0	Not much growth expected. Will likely hold steady.
Flying R Ranch Water Association	11	110.9	15.5	12.5	–3	Not much growth expected. Will likely hold steady.
Footehold Estates Water Association	1	11.8	2	3	1	Not much growth expected. Will likely hold steady.
Gold Blossom-Rivera Mutual Water Association	16	92.1	36	36	0	Likely nearing maximum capacity.
Greenpeace Water Association	10	79.6	0	7.5	7.5	Currently limited by freeze. Expect 10-12 MI following freeze.
Hda Association	18	63.8	10	11	1	Likely nearing maximum capacity.
Iron Mountain Mutual Water Company	19	215.4	43	49	6	Likely nearing maximum capacity.
Lake of The Pines Ranchos	190	1028.1				Possibility of 130+/- inches in next 5-10 years. May not form MWA, but demand will exist.
Little Greenhorn Creek	82	817.2	0	0	0	Limited by freeze. Likely 20 MI following freeze.
Meadow Hill Water Association	17	102.5	8	8	0	Not much growth expected. Will likely hold steady.

Mutual Water Company	Number of Parcels	Acreage	Phase I (M.I.)	2008 (M.I.)	Change	Anticipated Future Growth
Melody Oaks Mutual Irr Company	89	670.0	20	50	30	Boundaries have been growing and are expected to continue. Steady demand growth expected. Up to 150 MI in 10-15 yrs.
Moonshine Water Company	20	197.9	20	20	0	Likely nearing maximum capacity
Mount Vernon Est Mutual Water Company	8	44.2	14	14	0	Has growth potential
Mustang Valley Mutual Water	27	416.3	56	54	–2	Likely nearing maximum capacity
Oakcreek Water Association	11	58.5	13	13	0	Has growth potential
Ophir Prison East Mutual Water	24	54.0	16	16	0	Likely nearing maximum capacity
Perimeter Road Pipeline	12	140.2	30	30	0	Likely nearing maximum capacity
Quail Hill Acres Road	30	289.4	46	44	–2	Some growth. Currently limited by freeze.
Rainbow Pond Water Association	20	199.3	0	0	0	Have never bought water. Could begin to move forward at some point.
Redbud Water Association	21	96.5	20.5	20.5	0	Not much growth expected. Will likely hold steady.
Rudd Road Pipeline Association	9	129.1	14	17	3	Growth of several inches possible
Running Water Inc.	6	73.5	20	20	0	Likely nearing maximum capacity
Ridge View Woodlands	25		–	11.25		New MWA. Limited growth expected
Saddleback Water Association	41	103.0	3.5	9	5.5	Likely nearing maximum capacity
Sierra Foothills Water Association	13	457.2	30	30	0	Has growth potential
Sky Pines Mutual Water Association	18	44.3	0	10	10	Likely nearing maximum capacity
South Nevada Co Mutual Water	129	1691.0	0	0	0	Possibility of 160+/- inches in next 5-10 years. May not form MWA but demand will exist.
Streeter Road Water Association	38	308.7	33.5	34.5	1	Growth of several inches possible
Vian Water Association	5	61.1	20	20	0	Not much growth expected. Will likely hold steady.
Wilkes Pipeline Association	15	189.1	42	44	2	Slow, steady growth expected.
Totals			744	**797.25**		

4.1.6 Crop Reports

The District prepares annual crop reports that provide an estimate of the acreage being irrigated from each canal, and a breakdown of the irrigated acreage by crop. Review of historical crop reports during Phase I showed that pastureland and family gardens accounted for 80 to 85 percent of the irrigated land use within the District. Crop reports for the period 2002–2007 confirmed that the findings noted in the Phase I report that the primary land use of irrigated acres within the District remains pastureland and family gardens. Based on the 2007 crop report, these two categories account for 85.3 percent of irrigated lands in the Deer Creek system and 84.7 percent in the Bear River system.

The 2002 crop report indicated a total of 24,670 acres under irrigation, while the 2007 report identifies 27,843 acres under irrigation (9,864 acres for Deer Creek and 17,979 acres for Bear River), an increase of approximately 13 percent.

4.1.7 Assessor Updates

County Assessor's Parcel data served as the base layer for spatial modeling and presentation of soft service area boundaries and District infrastructure. Updated property ownership records supplied by the counties were merged with the District's customer database, allowing identification of current parcels by service facility (canal segment) for each property delineated by county assessor

4.1.8 Canal Soft Service Area Boundary Revisions

The canal soft service area boundary for each canal segment was developed as part of the Phase I effort. The boundary delineation was based on the parcels most likely to receive water within the period of this analysis, considering topography, distance from canal, and/or other obstacles to development of parcels. Soft service area boundaries are an estimate, given current site data, of which parcels may request raw water service during the planning horizon. If raw water demands occur, or are expected to occur, beyond the soft boundaries, the boundaries can be adjusted in future updates to include the new or anticipated service areas. Service area soft delineations developed during Phase I were reviewed for the Phase II work to determine whether, and where, boundary changes were appropriate. Exclusion from a soft service area boundary in no way precludes a parcel from receiving water in the future.

The District's 2007 customer data was overlaid on the parcel maps in conjunction with respective soft service area boundaries. Using this graphical display, necessary modifications to the soft service area boundaries delineated in the Phase 1 work were easily identified. Changes in the soft service area boundaries resulting from this review are shown in Appendix B. Within each revised soft service area boundary, the total number of parcels currently receiving water, and overall acreage for each area, was estimated by type of service (raw, treated, or dual).

These data are necessary for estimating the future flow demand and infrastructure needs for each of the canal segments. As shown in Table 4-3, the total 2007 soft service area boundary acreages increased by 4.6 percent for the Deer Creek system but remained virtually unchanged for the Bear River system over the total areas delineated in 2002. These acreages represent the gross area of parcels within the soft service area boundaries. During this timeframe, there was also an increase in area receiving water within the Deer Creek and Bear River systems of approximately 9 percent.

TABLE 4-3. TOTAL SOFT SERVICE AREA BOUNDARIES AND RAW WATER CUSTOMER ACREAGES

System	2002		2007	
	Total Area (Acres)	Total Acres Receiving Raw Water	Total Area (Acres)	Total Acres Receiving Raw Water
Deer Creek	92,030	38,447	96,292	41,869
Bear River	90,159	44,837	90,270	49,249
Total	182,189	83,284	186,562	91,118

4.2 MODEL STRUCTURE

The model provides a tabulation of the average and peak flow for each canal segment. The tabulation can be provided for the District as a whole, the major systems – Deer Creek and Bear River – or for each major canal system. The model is also capable of reporting in a format that matches closely with NID's annual Water Recap Report.

The basic concept of the model is that demand or canal flow for each canal segment is computed by applying the respective duty rate (acre-feet/acre) to the anticipated, or future, gross land area receiving water and then adding back in the appropriate canal conveyance losses. This approach was adopted because use of the gross acre parcel approach is based on finite, quantifiable data. The gross acre parcel approach accounts for each acre within the District, whether or not it is receiving water.

Ultimately, the model estimates total annual demand for water—raw and treated, summer and winter—within the District's service area. A significant portion of the demand projections focuses on estimation of demand for raw water during the summer irrigation season. The reason for this is that water use (demand) during the irrigation season represents the majority of the District demand. Demand for water during the winter months is relatively constant and, as such, was incorporated in this model as a constant.

This section details the approach employed in the calculation of the District's raw water demands, and identifies assumptions and constants employed.

4.2.1 CANAL SOFT SERVICE AREA BOUNDARIES

The soft service area boundary was derived for each canal segment within the District (Appendix A). The existing soft service area boundary saturation level, or percentage of gross parcel acreage currently receiving District water (either treated, raw, or both) within each soft service area boundary, was determined for each of the District's canal segments. An estimated ultimate saturation level was assumed and used as an estimate of full build-out, which in turn was used as a cap to future growth for this analysis. If the acreage receiving raw water within any canal segment reached the set saturation target level, the model prevented further growth in that segment. This threshold was set to preclude the model from overestimating the available acreage and ultimate build-out within the specific canal service areas. A value of 80 percent was used as a typical value to represent full build-out in the model. This value is a variable in the model and can be changed as required for any specific canal segment.

4.2.2 CANAL FLOWS

Canal flows are made up of two components: flow that is applied to the land or used for consumptive purposes, and canal losses. The process used to derive the canal flow, and thus the system demand, is the same as that shown in the Phase I report. Figure 4-4 illustrates the process. For the Phase II update, the 2007 customer and flow data are used as the base year.

For the summer irrigation season, canal flow data are used to calculate the average and maximum flow for each canal segment for the 183-day irrigation period of April 15 through October 15. The computed canal flows included both raw and treated water, as applicable. Considerations were also made for canals where flows were added via pumping and/or flow augmentation from an alternative source.

4.2.3 CANAL LOSSES

Canal losses include three types of water loss: conveyance (seepage) losses, evaporation losses and exit (end) losses. The literature (Etcheverry, 1915) notes that evaporation losses on small canal systems are "generally less than 10 percent of the quantity lost by seepage."[2] Conveyance losses, which are derived rather than directly measured, are estimated based on data from several canal segments that had sufficient information to estimate canal losses, data provided by the District, engineering judgment based on the canal types (lined and unlined), segment configuration, piped or siphoned segments, and soil types. Five factors that affect seepage losses in canals are:

1. Soil type
2. Location of water table
3. Age of canal and amount of silt carried in the water
4. Depth of water in the canal
5. Velocity of water in the canal

The most significant factors are soil type, age of the canal, silt load, and velocity of the water in the canal. The soil type through which a canal passes is a factor in the seepage/percolation losses.

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[2] Extent of Conveyance Losses in Canals. The conveyance losses are due to seepage and evaporation, and in some cases the regulation loss at waterways is also included, but this is not customary and will not be considered here. The evaporation loss is generally very small as compared to the conveyance loss; it will seldom be as much as 10 percent of the conveyance loss and will generally be not over 5 percent. For this reason the term *seepage loss* is frequently used in the same sense as conveyance loss without making any deduction for the evaporation loss. (Etchiverry, 1915).

For example, a granular material will have a high rate of seepage whereas a canal through a silty loam or clay material will have a much lower seepage rate. In locations where the predominant soil type is granular material, some type of impervious lining is typically used. Age of the canal is important because fine sediments that have been transported along the canal accumulate over time, tending to "seal" the canal bottom surface and reducing seepage losses. Thus, work done to a canal that disturbs the accumulated sediments can, in the short term, increase seepage losses until the sediment deposits can again seal the canal.

Flow velocity can also significantly affect canal seepage losses in several ways. High velocity flows can erode the fine silts that are effectively sealing the canal and expose the more porous sub soils, thereby increasing seepage losses. Studies have also shown that moving water percolates less than standing water (Etcheverry, 1915). As a design guide, the Bureau of Reclamation has determined that a bottom velocity of approximately 1.5 feet per second is the optimal design velocity. Flows exceeding this velocity will begin to cause erosion and increase seepage, while too low a velocity will allow more time for seepage.

Velocity also affects vegetative growth in and along canals, which increases seepage losses as it slows down flows near the bottom and sides of the canals. Studies have shown increases of up to 60 percent in seepage losses within vegetated canals in comparison to a similar non-vegetated canal (Etcheverry, 1915).

The Bureau of Reclamation reports for preliminary purposes, losses in unlined earthen canals may be estimated to be one third of the total water carried. Other references note total canal losses that vary from 13 to 55 percent. As used in the Phase I effort, an overall conveyance loss of 15 percent was used for the updated model. The loss estimate for individual canal segments was adjusted proportionately if the canal segment was noted to be partially lined, piped, or siphoned. Consequently, at some locations the estimated conveyance loss exceeded 15 percent. Review of the canals indicated that there has been no appreciable change in the canal system that would affect these values. Therefore, the same conveyance loss percentages used in the Phase I report are used in Phase II.

Exit losses are flows leaving the end of a respective canal segment. Exit losses vary from canal to canal and are a function of customer uses, flow demands through the canal, and District operation practices. For those canals with gaged exit flows, the measured flows were used. For the canal segments with ungaged exit losses, losses were estimated based on their similarity with neighboring segments containing gages, area served by the canal, discussions with the District's Operations personnel, and data compiled as a result of Phase I efforts.

4.2.4 RAW WATER FLOWS CONVEYED TO WATER TREATMENT PLANTS

Water is supplied to the seven District water treatment plants via the canal system, as well as to facilities operated by Grass Valley and Nevada City; thus treated water demand is included in the raw water calculations. Existing and future water demands dedicated to the water treatment plants are variables in the model.

4.2.5 GROSS ACREAGE DUTY RATE

The major variable for the raw water demand calculation is the amount of water applied to the land, or the duty rate. The gross acreage duty rate for each canal segment is computed using the flow gage data, estimated conveyance loss, exit loss, treatment plant demand, and the customer parcel data.

The duty rate derived for each canal segment was applied to the respective gross area "in use" acreage value to determine volume of water applied to the land. The resulting volume was then adjusted to include the appropriate losses to determine the average irrigation season canal segment flow. The resulting flows for each canal segment were then summed in the appropriate order to derive the total average flow for the major canal segments.

4.2.6 GROWTH RATES

The two underlying assumptions in deriving the future raw water demand are that the historical land use applications will remain constant, and that growth in terms of land development will continue at a constant annual rate for the period of this update.

In general, an annual growth rate of 2 percent is assumed in the model. This assumption is slightly higher than the growth shown by recent trends in the treated water system, however, based on District strategic planning goals growth of the treated water is expected to increase at approximately 2 percent annually. This assumption is also slightly higher than historic growth in the raw water system, however, numerous systems in the District have been frozen for a number of years due to the need for large infrastructure projects. A number of these projects are currently under construction and are expected to be completed in the near term; consequently, the District anticipates growth in the system in the near term.

The demand model has been developed with the ability to alter the growth rate for each canal segment should future growth projections be revised, or if sensitivity analyses to assess the impact of varying growth rates is desired. This capability was utilized for those canal segments where development of mutuals can substantially increase demand in a short period of time. Once the growth rate is input to the model, it is applied as an annually compounded rate based on the selected year interval, beginning in 2008 and continuing forward in any desired time-period increment, for a total of 25 years into the future.

4.2.7 External Deliveries

The District provides, when available, contract or surplus water to South Sutter Irrigation District as well as to other surplus customers and non-annexed railroad commission order parcels (RCO). There are three RCOs, two of which are located within District boundaries: Gold Hill system (RCO 26098) and Deer Creek system (RCO 17824). The Excelsior Water and Power Company system (RCO 15926), a portion of which is located outside the District boundary.

In the Phase I analysis, it was determined that 9,893 acres of the defined area in this Order are located outside the District, with a total of 2,330 acres currently receiving water. Based on the 2007 data, this does not appear to have changed. The District reported that approximately 5,000 acre-feet of water was delivered to surplus and external RCO customers in 2007. These are incorporated in the demand analysis. No deliveries were made to South Sutter Irrigation District in 2007. The water delivered to South Sutter Water District is, however, not included in the demand projections because it is water purchased from PG&E and is delivered through PG&E facilities.

4.2.8 Environmental Flows

Under the 1963 California Department of Fish and Game Agreement and from terms in water right permits and licenses, the District releases water to maintain environmental conditions in creeks and rivers downstream of District facilities. Approximately 7,700 acre-feet of these flows are non-recoverable by the District and therefore represent a loss to the system. This volume is included in the overall system water demand. It should be noted that this value may change as a result of the District's Yuba-Bear Hydroelectric Project FERC relicensing, currently in progress. However, any changes resulting from this process will not take place until 2013. Any changes in required environmental flows as a result of the relicensing can be easily modified in the demand model.

4.2.9 Conservation Measures

Conservation measures taken by the District to conserve water include measures to reduce losses, such as lining or piping of canal segments or changes in land application methods to reduce overall demand. The demand model has the ability to adjust the calculations to account for future conservation measures, which will be presented as a percentage value. Values can be input as percentage savings of demand for each canal segment and would be entered in the year that it takes effect.

4.2.10 Future Raw Water Demand Estimates

Future raw water flows for each canal segment or lateral are calculated by multiplying the canal-specific duty rate (in acre-feet/acre) by the anticipated future acreages receiving raw water. This product provides the volume of water that could be applied to future raw water parcels within each specific canal soft service area boundary. Canal conveyance/exit losses are then added to the land application flows to obtain the total average flow/demand for each canal segment.

Canal flows for each canal segment are then summed in order of their distribution network for each canal subsystem to derive a total flow demand at the head of each major canal. The major canal segments are then totaled to determine the overall demand for the Deer Creek and Bear River systems, which are then summed to determine the District irrigation season demand. Winter flows, and environmental flows are added to these totals to compute the total District demand for the given year.

4.2.11 DERIVATION OF CANAL PEAK FLOWS

Peak canal flows are used to design the canal conveyance structures. Future peak flows were derived using the average demand values multiplied by the average historical peak to average ratio for each canal segment. In order to account for the annual variations that occur in the system due to changing hydrologic conditions, the average of the ratio of annual peak flow to average annual flow was used for the period 2002–2007 to derive the peak flow in this analysis.

As a check on the rationality of this assumption, the peak to average ratio for the 165 District gages computed for the period 1992–2005 ranged from a low of 1.08 to a high of 2.8, with one gage reaching a value of 4.0. The overall District average for the period was 1.47. A similar calculation was done for the 2002–2007 period used in this analysis and the range of peak to average values was virtually identical to the long-term period. The overall average for that period was 1.48, indicating that the 2002–2007 period average is a reasonable representation. Table 4-4 provides a comparison of the estimated (modeled) peak flow results for select canals between Phase I and Phase II.

TABLE 4-4. COMPARISON OF PEAK FLOW ESTIMATES FOR PHASE I AND PHASE II OF RAW WATER MASTER PLAN MODEL

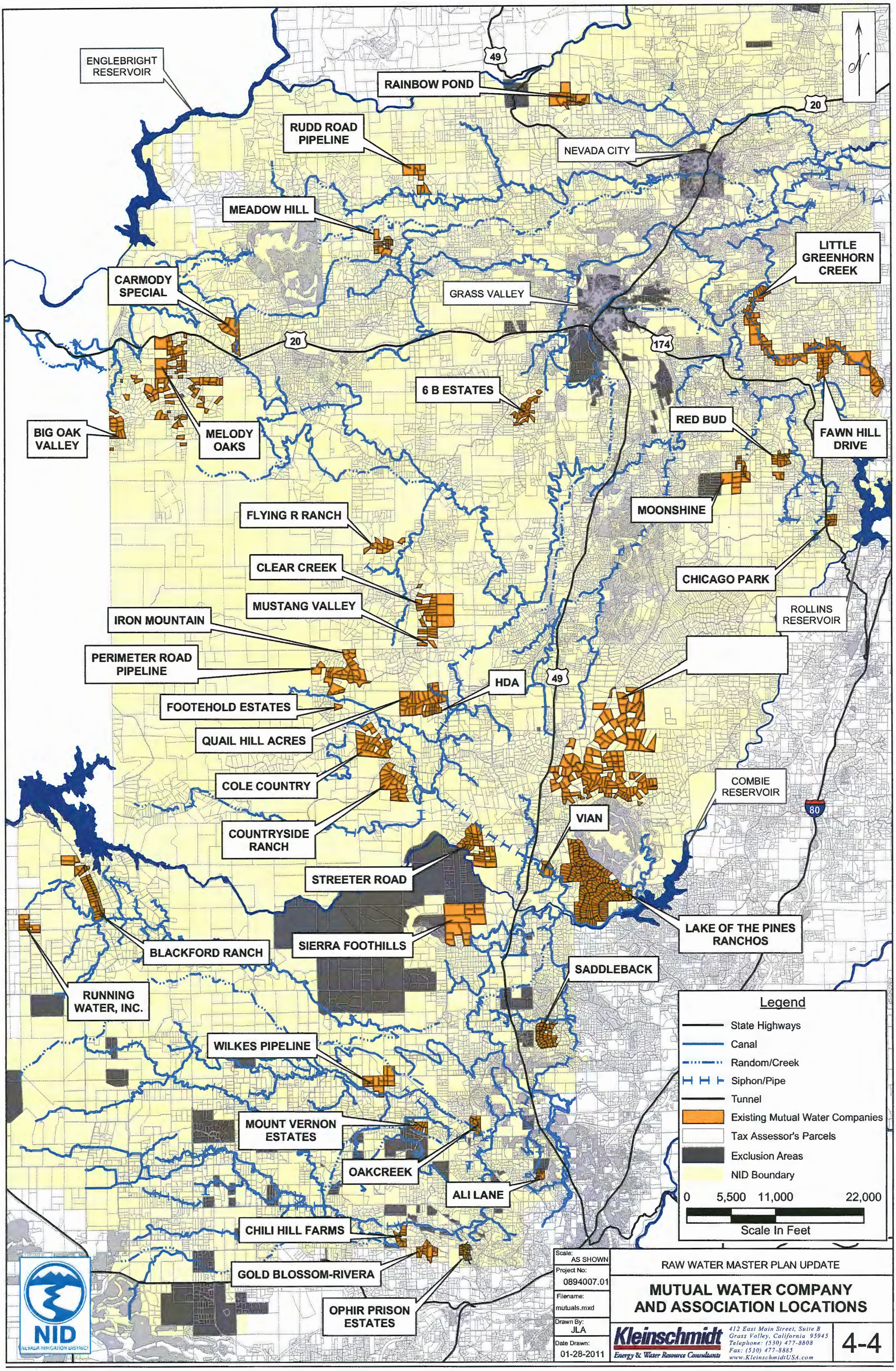
		Estimated Peak Flow (cfs)		
		Phase I	Phase II	
Canal (Gage at Head)[1]	Schematic[2]	2027	2028	2032
Snow Mountain Canal (DC 118)	D1	6.2	6.7	6.7
Newtown Canal (DC 131)	D2	23.1	21.1	22.7
DS Canal (DC 145)	D3	92.5	89.6	94.9
Tarr Canal (DC 169)	D5	68.6	61.7	63.2
Cascade Canal (DC 102)	D9	107.6	83.4	86.3
Chicago Park Canal (DC 105)	D7	54.4	49.6	52.3
Rattlesnake Canal (DC 114)	D7	31.6	23.0	24.0
Camp Far West Canal (BR 334)	B2	56.1	58.7	62.4
Combie Phase I Canal (BR 301)	B3	197.4	202.1	212.1
Combie Ophir I Canal (BR 313)	B4	138.9	134.0	139.4
Combie Ophir IV Canal (BR 351)	B5	36.1	34.0	34.5
Deadman's Ravine Natural (BR 352)	B6	23.2	28.6	29.20
Auburn Ravine I Canal (BR 100)	B7	97.2	82.7	84.5

[1] *DC = Deer Creek system, BR = Bear River system*
[2] *Refers to the sheets in Appendix D*

The results as shown in Table 4-4 note, in some instances, substantial variation between the Phase I 2027 peak flows and the revised Phase 2 2028 peak values. As outlined above, the peak values are computed based on the peak to average ratio. This ratio is variable because the average flow can vary depending on the period as well as the historical peak flow used to derive the peak to average ratio. Hydrologic conditions and customer demand, as well as the number of customers, vary from year to year which impacts the average flow and thus the peak flow. Another source of variation is the change in the soft service area boundary for each canal segment. Changes in service area can impact the average flow and thus the average demand, which is used to derive the peak flow. In order to account for this variation, the District typically uses the peak demand increased by 25 percent for design purposes. This factor covers both the variation that can result in the peak flows as well as making an allowance for variation in the growth projections.

4.3 RAW WATER DEMANDS (AVERAGE AND PEAK) FOR CANAL SYSTEM

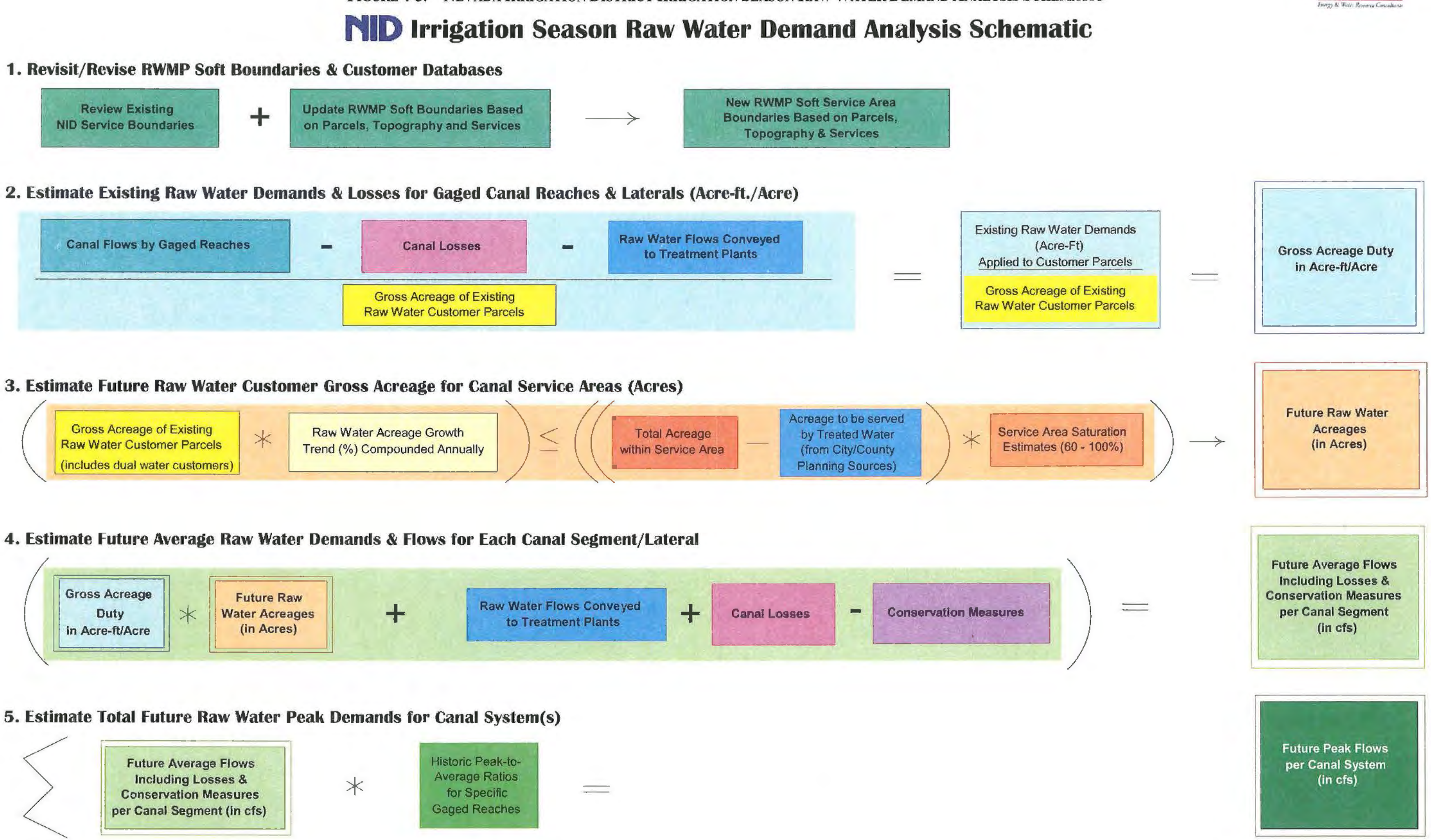
Using the approach and assumptions detailed in previous sections, the demand was computed for each canal segment, as well as for the District as a whole (Figure 4-4). The computed flow for each canal segment was then summed in the appropriate ascending order to derive the average flow for each canal system. The computed values represent the application of the derived duty rate to the gross acreage receiving water and the addition of the applicable conveyances and exit losses. As a check on the accuracy of the methodology, the computed results for each canal segment for 2007 were compared to the gaged 2007 flow data and found to match very closely, indicating the resulting model would be a good predictor of future demand. Similar results were found when the model was compared to the 2002 data in the Phase 1 analysis. The model was then run to forecast future water demands for the period 2008–2032. Peak flows for the various canal segments were derived by multiplying the respective average values by the average peak to average flow ratio value.



ENGLEBRIGHT RESERVOIR
RAINBOW POND
RUDD ROAD PIPELINE
NEVADA CITY
MEADOW HILL
LITTLE GREENHORN CREEK
CARMODY SPECIAL
GRASS VALLEY
BIG OAK VALLEY
MELODY OAKS
6 B ESTATES
RED BUD
FAWN HILL DRIVE
MOONSHINE
FLYING R RANCH
CHICAGO PARK
CLEAR CREEK
MUSTANG VALLEY
IRON MOUNTAIN
ROLLINS RESERVOIR
PERIMETER ROAD PIPELINE
HDA
FOOTEHOLD ESTATES
QUAIL HILL ACRES
COLE COUNTRY
COMBIE RESERVOIR
COUNTRYSIDE RANCH
VIAN
STREETER ROAD
LAKE OF THE PINES RANCHOS
BLACKFORD RANCH
SIERRA FOOTHILLS
SADDLEBACK
RUNNING WATER, INC.
WILKES PIPELINE
MOUNT VERNON ESTATES
OAKCREEK
ALI LANE
CHILI HILL FARMS
GOLD BLOSSOM-RIVERA
OPHIR PRISON ESTATES
49
20
174
80
N
Legend
State Highways
Canal
Random/Creek
Siphon/Pipe
Tunnel
Existing Mutual Water Companies
Tax Assessor's Parcels
Exclusion Areas
NID Boundary
0 5,500 11,000 22,000
Scale In Feet
NID
NEVADA IRRIGATION DISTRICT
Scale: AS SHOWN
Project No: 0894007.01
Filename: mutuals.mxd
Drawn By: JLA
Date Drawn: 01-28-2011
RAW WATER MASTER PLAN UPDATE
MUTUAL WATER COMPANY AND ASSOCIATION LOCATIONS
Kleinschmidt
Energy & Water Resource Consultants
412 East Main Street, Suite B Grass Valley, California 95945
Telephone: (530) 477-8808
Fax: (530) 477-8885
www.KleinschmidtUSA.com
4-4

FIGURE 4-5. NEVADA IRRIGATION DISTRICT IRRIGATION SEASON RAW WATER DEMAND ANALYSIS SCHEMATIC

Kleinschmidt



4.3.1 WATER DEMAND ASSUMPTIONS AND ANOMALIES

An important assumption in the demand model is that the model assumes the normal, or usual, flow routing for the District. Operation of the canal system requires and has many options for flow routing in order to address maintenance and emergency conditions as they arise during daily operations. For example, in 2007 the District made use of purchase options from the PG&E Consolidated Contract, supplying the Camp Far West Canal by transferring water through Rock Creek rather than its normal route through the Orr Creek release. This affects the flows in canals such as the Combie Ophir I and Ophir Pipe. The model does not consider the various rerouting scenarios, thus the capacity of the canals could be considerably different as a result. It was also assumed that there would be no pumping from the DS Canal to the Chicago Park system.

With completion of the District's Banner Pipeline, it is assumed that the Cascade system will be able to provide all flows to the lower Cascade system including the Loma Rica and E. George Treatment Plants, and no pumping from the DS Canal to the Chicago Park system will be required. Until completion of the Banner Pipeline, flows in the Upper Grass Valley system will include the flows reported for the E. George Treatment Plant. However, once the Banner Pipeline is completed, flows to Upper Grass Valley will not include the E. George Treatment Plant flows. For this reason, we have separated them on the summary sheets.

Current and future flow demands computed for the Lone Star, Rudd, and Rainey Canals were based on the gage data for that system (BR 318, BR 320, and BR 317). Flows to these canals are pro-rated, however, and demand may increase more than predicted if capacity to this area is increased in the future. Additionally, sales on a number of canals are currently frozen as they are at or exceed their maximum design capacity; no special consideration for demand or timing of future flows for these canals was included in the model.

For the Phase II work, water demand for the proposed RWSP in the Lincoln area was included in the analysis. Data regarding the demand and scheduling for the proposed facility was provided by ECO:LOGIC. The initial project demand is anticipated to be approximately 3,700 acre-feet with a peak day flow demand of approximately 10 million gallons per day (MGD), or 15 cfs. Ultimate build-out average plant demand is anticipated to be approximately 16,755 acre-feet with a peak day flow demand of 40 MGD, or approximately 65 cfs. The proposed build-out scheme is anticipated to be completed in three phases: Phase 1 will occur in 2015, Phase 2 in 2023, and Phase 3 in 2032. It is proposed that flows for the plant will come from the Combie Reservoir through the Bear River system. For the initial stages, flows will be conveyed to the facility through the canal system. Ultimately, however, flows will be conveyed to the facility via a dedicated pipeline. At this time, the projected RWSP demands have been added to the future demand calculations for the Combie system.

4.3.2 MODEL RESULTS

The average flow/demand for the Deer Creek and Bear River systems was calculated by totaling the average flow values for the respective canal systems. The sum of the flow demand for these two major systems, environmental flows, and winter water result in the total District raw water demand.

The model results for the calibration year were compared to values in the Water Recap Report for 2007. This annual report summarizes the total District water sales, which represent the District net demand. However, these values are considered net demand, as they do not include the conveyance losses or environmental flows. For a direct comparison, the water sales data from the 2007 Water Recap Report were increased by a factor representative of the system losses. The modeled 2007 water demand was determined to be 162,857 acre-feet. The net demand reported in the 2007 Water Recap Report, when adjusted for conveyance losses, resulted in a total demand of 167,716 acre-feet. These values compare within 2 percent of each other. Table 4-5 summarizes the results of the current (2007) computed gross system demand versus the Water Recap Report data.

For the forecast demand values, the peak and average flows for each major canal system and lateral were computed by using the anticipated future increase in customer acreage within each canal soft service area and applying the computed duty rate to that acreage. Appendix C contains summary tables of the results of the demand analysis for the irrigation season for the period 2008 to 2032 in 4-year increments. Appendix D contains schematic drawings of the raw water system, including estimated peak flows for the modeled period.

TABLE 4-5. SUMMARY OF WATER DEMAND ANALYSIS – 2007 DATA

SYSTEM	MODELED AVERAGE DEMAND (CFS)		MODELED AVERAGE DEMAND (ACRE-FEET)		MODEL AVERAGE ANNUAL TOTALS (ACRE FEET)		TOTAL VOLUME WATER RECAP REPORT (ACRE-FEET)
	SUMMER	WINTER	SUMMER	WINTER	DEMAND	DELIVERIES	
Deer Creek	130	42	47,065	15,100	62,165	54,519	52,003
Bear River	203	53	73,813	19,178	92,991	79,042	83,604
Subtotal			120,879	34,278	155,157	133,561	135,607
Environmental Flow					7,700		7,700
Estimated Losses					Included		24,409
Total Raw Water Demand					162,857		167,716

As an additional check on these values, an estimated demand was computed using a trend analysis based on District water sales data. Plotting the water sales data for the period 1985 to the present and fitting a trend line to the plot, the trend for water sales notes an increase of approximately 1,000–1,100 acre-feet per year. For the District demand in 2016, we added an estimated 5,000 acre-feet to the actual 2007 system demand of 167,716 acre-feet to accommodate the proposed development of the larger mutuals and the Regional Water Supply Project (RWSP) within that timeframe. We then added the 1,000 acre-feet/year value derived from the historical data for general growth to derive a total estimated demand in 2016. This approach resulted in an estimated demand in 2016 of 181,716 acre-feet, versus the modeled 177,322 acre-feet. Using a similar approach for 2028, the estimated demand, not considering any further proposed increase in demand for the RWSP, was determined to be 193,857 acre-feet, versus the 198,336 acre-feet computed by the model. These projections are reasonably close to the value computed by the model (as updated for the Phase II work) and fall in line with the results of the original model developed during the Phase I work. The future demand forecast, as modeled for the period 2008–2032 in 4-year time increments, are summarized in Table 4-6. These numbers include projected demand from the mutual water companies and the RWSP. It should be noted that the model computed anticipated demand and does not consider the ability of the District to deliver the water as computed. These issues are/would be addressed as part of the capital improvement plan.

TABLE 4-6. SUMMARY OF DEMAND ANALYSIS FORECAST IN ACRE-FEET (MODEL)

	BEAR RIVER IRRIGATION	DEER CREEK IRRIGATION	WINTER WATER	ENVIRONMENTAL FLOWS	TOTAL DEMAND
2008	71,817	45,933	32,946	7,700	158,395
2012	76,302	50,009	32,946	7,700	166,956
2016	82,573	54,104	32,946	7,700	177,322
2020	86,445	57,452	32,946	7,700	184,543
2024	90,777	60,633	32,946	7,700	192,056
2028	94,296	63,394	32,946	7,700	198,336
2032	98,141	66,392	32,946	7,700	205,180

4.3.3 SIGNIFICANT GROWTH DEVELOPMENTS

Looking forward, there are some potentially significant areas of growth over and above normal District growth that should be considered within the next 10-year planning period. These include the potential development of two mutual water companies: Lake of Pine Ranchos and South Nevada County Mutual Water Company. Together, they have a potential total demand of approximately 300 MI, or 7.5 to 8 cfs, which equates to an irrigation season demand of approximately 2,772 acre-feet. The other large future development is the RWSP near Lincoln, which is projected to have an initial annual demand in 2015 of 3,700 acre-feet, or 5 cfs. Together, these developments account for approximately 6,500 acre-feet of potential additional demand by 2016.

5.0 WATER RESOURCE ASSESSMENT

Assessing the adequacy of the District's water supply to accommodate future needs requires an understanding of available water resources and the demand for water consumption over time, combined with the capacity of the District's infrastructure and conveyance system. In this section, we examine these factors and evaluate the District's ability to meet projected demand 25 years into the future.

5.1 WATER SUPPLY

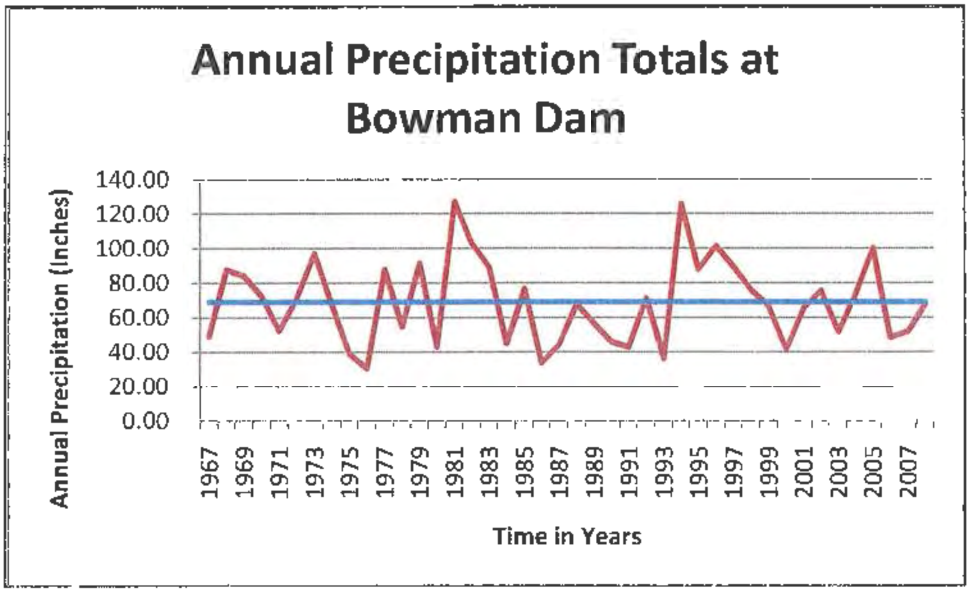
The District's water supply comes from four main sources: natural runoff from the contributing watershed area, carryover storage, contract water purchases, and recycled water.

5.1.1 NATURAL RUNOFF

Of the four sources of supply, the primary contributor is the natural runoff within the watershed. The natural runoff volume available in any given year is highly variable and subject to a variety of conditions. The most prominent and obvious cause for the fluctuation in natural runoff is the variability in hydrologic conditions, as seen in the wide variations in annual rainfall/snowpack accumulations. Historically, runoff has fluctuated from less than 100,000 acre-feet in a dry year to over 400,000 acre-feet in wet years. Average runoff from the upper division watershed, including the watershed area feeding Scotts Flat Reservoir, is approximately 237,600 acre-feet. (This volume does not include the natural runoff contribution from the Bear River watershed into the Rollins Reservoir.) PG&E has reported that the average runoff from the Bear River watershed into Rollins Reservoir is approximately 173,000 acre-feet.

Precipitation data from the gage maintained at Bowman Dam (Figure 5-1) shows the long term annual average precipitation to be approximately 69 inches. Records for the last 43 years show that the annual precipitation totals have varied from a high of 127 inches to a low of 30 inches. Data for the most recent five-year period indicates that two of the five years, 2006 and 2007, had precipitation totals that were approximately 21 and 17 inches below the average value, respectively.

FIGURE 5-1. ANNUAL PRECIPITATION AT BOWMAN DAM



Note: The blue line is the average precipitation for the period 1967–2009, which is 69 inches.
Source: NID

5.1.2 CARRYOVER STORAGE

Carryover storage is the second largest component of the District's supply. Carryover storage is the volume of water left in storage reservoirs at the end of the irrigation season, and is used to provide a buffer in the event the following water year is below average. Carryover storage is affected by reservoir capacities and minimum pool requirements. As a result of the Phase I analysis, NID increased the minimum carryover storage volume from 70,000 acre-feet to 78,000 acre-feet to account for increases in demand within the system. It is important to note that of this carryover storage, 39,675 acre-feet is considered dead storage and/or minimum pool storage, and is not available for use to meet system demand. Historically, the average annual carryover storage for the period 1968–2009 was 146,939 acre-feet, approximately 107,300 acre-feet of which are considered useable.

5.1.3 PURCHASED CONTRACT WATER

Purchased contract water is available through a contract with PG&E. Currently, the District may purchase up to 59,361 acre-feet of water annually, subject to availability during drought periods. During a dry year, PG&E can reduce this volume to 23,591 acre-feet, a quantity less than half of the maximum purchase entitlement. It is possible that this quantity may change when the PG&E

Consolidated Contract expires in 2013. The contract is under evaluation concurrent with the joint NID/PG&E relicensing of the Yuba-Bear Project.

5.1.4 Recycled Water

Recycled water, the final component of supply, is water that is returned to the system from wastewater treatment plants. While this currently accounts for a small volume—approximately 3,400 acre-feet annually—this will become an increasingly important water source as implementation of conservation and other such measures are required.

5.1.5 Seasonal Considerations

The water supply is dependent on snowmelt and winter period rains to fill storage reservoirs, and the District manages its system based on the timing of those events. While there is some natural runoff during the summer months, the irrigation season (April–October) demand is met primarily with withdrawals from storage reservoirs. Careful management and operation of the storage reservoirs is required to capture the maximum amount of runoff, minimize spillage from the reservoirs, yet insure that there is sufficient volume available in the reservoirs to accommodate runoff during the spring snow melt and storm events. The total useable volume from the District's reservoirs is estimated at 238,620 acre-feet annually (Table 5-2), assuming all are at their full pool level (Water Rights). Reducing this by 39,675 acre-feet of minimum carryover storage results in a total available volume of approximately 198,945 acre-feet during the irrigation season.

5.2 Water Rights

The amount of water NID is able to capture is based upon the combination of pre-1914, riparian, and appropriative water rights. At present, the State Water Resources Control Board (SWRCB) has issued five permits and eight licenses, which allows NID the consumptive use of water from various sources. The 1963 Yuba-Bear Project Consolidated Contract, along with supplemental agreements signed with PG&E (expiring on July 13, 2013), are also important sources of water for the District.

5.2.1 EXISTING WATER RIGHTS

A detailed review of the water rights held by the District was made to determine the total quantity of water available by diversion and storage for use by NID. Water rights are summarized in two categories, pre-1914 water rights and post-1914 appropriative water rights.

Our review identified numerous pre-1914 water right claims, however the full extent of these rights is difficult to quantify. Previous reports specify that NID has pre-1914 rights for Deer Creek, Canyon Creek, Middle Yuba River, South Yuba River, Bear River, Wolf Creek, Coon Creek, and Auburn Ravine.

Post-1914 appropriative water rights include direct diversion and diversion to storage. Five applications for post-1914 water rights are currently in the licensing process by the State Water Rights Control Board (SWRCB). Our review identified 13 post-1914 water rights applications and/or licenses which allow for the diversion and storage of water for consumptive use. Four of these are in Placer County with the remainder in Nevada County. These post-1914 water rights applications and their current status before the SWRCB are summarized in Table 5-1.

NID also has numerous other rights that allow diversion for hydroelectric power production but these are non consumptive rights.

TABLE 5-1. SUMMARY OF POST-1914 CONSUMPTIVE WATER RIGHTS

APPLICATION NUMBER	LICENSE	FACILITIES OR SOURCE	COUNTY OF LOCATION
1270	12795	Jackson Creek, Canyon Creek, and Tributaries (Clear, Texas, Fall, Trap, and Rucker Creeks)	Nevada
6702	12800	Clear, Trap, Fall Creek	Nevada
8177	12801	Wilson Creek	Nevada
8180	In Process	Clear, Texas, Fall, Trap, Rucker Creek	Nevada
2276	12797	Middle Yuba River	Nevada
2652A	10350	Bear River	Placer
2652B	In Process	Bear River	Placer
20017	In Process	South Yuba River	Nevada
1614	In	Deer Creek	Nevada

APPLICATION NUMBER	LICENSE	FACILITIES OR SOURCE	COUNTY OF LOCATION
	Process		
1615	8808	S.F. Deer Creek and Deer Creek	Nevada
5193	In Process	Middle Yuba River	Nevada
6229	8809	Bear River	Placer
6529	4403	Auburn Ravine	Placer

Those applications identified in Table 5-1 as "In Process" are without license numbers and are under review. It is unknown when licenses will be issued. However, no significant adverse issues are expected to result from this licensing process that will impact the water supply of the District.

The total quantity estimated for use under current water rights totals approximately 450,000 acre-feet on an annual basis (Table 5-2). The total water right volumes consist of storage rights, direct diversion rights, and some a combination of both. The water right entitlements are subject to water availability in each year. During drought conditions, the volume of supply will be primarily based on availability rather than water right limitations.

TABLE 5-2. SUMMARY OF CURRENT WATER RIGHTS VOLUME

Facility/Source	Total Reservoir Capacity (acre-feet)	Usable Capacity[a] (acre-feet)	Current Water Rights Total (acre-feet)
Jackson Meadows[f]	67,435	48,205	220,000[b] (Combined Total)
Bowman[f]	68,363	68,363	
Jackson	1,330	970	
Faucherie	3,980	3,731	
Sawmill	3,030	3,030	
French	13,840	12,937	
Total Upper Storage	**157,978**	**137,236**	
Rollins[f]	58,682	53,682	115,000[c] (storage) 80,000[c] (direct diversion)
Combie	5,555	4,155	
Scotts Flat	48,547	43,547	
Total Lower Storage	**112,784**	**101,384**	
Grand Total	**270,762**	**238,620**	
Bear River, Deer Creek, S.F. Deer Creek and Auburn Ravine	68,500[d]	68,500[d]	35,000[e]
Total	**339,262**	**307,120**	**450,000**

[a] Usable reservoir capacity is the total capacity less the higher of dead storage or minimum pool.

[b] The estimated water right limitation is based on combined water right and direct diversion plus storage/withdrawal quantity terms contained in licensed water rights.

[c] The estimated water right limitation is based on MBK's July 23, 2003 memorandum to Kevin Long of the Division of Water Rights regarding proposed license quantities. Quantities may be reduced and further limited by the Division of Water Rights during licensing process. This is not expected to occur. The quantity of 80,000 acre-feet for the direct diversion under the post-1914 appropriative water rights is based on rate of diversion, season, and estimate of water availability. The sources of water are the South Yuba River, Texas, Clear, Fall, Trap, and Rucker Creeks.

[d] Rate of diversion over authorized season for Bear River, Deer Creek, S.F. Deer Creek, and Auburn Ravine under post-1914 appropriative water rights.

[e] Limited based on assumed availability.

[f] Storage is based on 2007/2008 bathymetric studies.

While the District's water rights total approximately 450,000 acre-feet, subject to availability, the historical average available supply, including natural runoff, normal carryover storage, contract water, and recycled water is approximately 356,300 acre-feet (Table 5-3).

TABLE 5-3. AVERAGE ANNUAL WATER AVAILABILITY

Source	Average Amount Available (acre-feet)
Watershed Runoff[a]	237,600
Carryover Storage[b]	107,300
Contract Water[c]	8,000
Recycled Water[d]	3,400
Total Annual Average Volume Available	**356,300**

[a] Average watershed run-off from 1968 – 2009. Includes Middle Yuba River above Milton Diversion, Canyon Creek above Bowman Dam, Texas Creek, Fall Creek and Deer Creek.

[b] Average end of October carryover storage of 146,939 from 1968 – 2009 minus 39,675 unusable acre-feet.

[c] Includes B-9 (Deer Creek), B-12 (Rock Creek and Wise), B-13(a), and supplemental water purchases.

[d] Average available recycled water volume returned to the system as reported in 2005 UWMP

Historically, the annual average volume of water available to the District basis is approximately 356,300 acre-feet (Table 5-3).

5.2.2 WATER RIGHT ISSUES

Current and/or pending actions by the SWRCB and other regulatory agencies warrant identification in regards to water rights. They are as follows:

Water Rights Compliance

The SWRCB is becoming more stringent with enforcement to ensure compliance with water rights. NID should be aware of these issues and ensure that they are operating in compliance with their water rights.

Pre-1914 Water Right Quantification

The SWRCB is pursuing opportunities to quantify pre-1914 water rights. This could be a difficult and time consuming task for the District. Quantification of these diversions may impact District operations.

1963 Yuba-Bear Project Consolidated Contract and Supplemental Agreements Signed with PG&E

This contract, terminating on July 13, 2013, is an important source of water to NID. It is anticipated that this contract will be renegotiated and renewed at the proper time with no reduction in available contract water.

FERC Hydro-relicensing (2013)

The Yuba-Bear FERC license (FERC No. 2266) expires in July 2013. As part of relicensing efforts, there is the potential for increased environmental flow requirements, which could potentially impact NID supply. In most instances, the minimum flow can be recovered and there is no loss of supply, however, timing may be an issue. There may be some instances where providing an increased environmental flow will result in a net loss to the District.

Overall, the District appears to be well situated in regards to water rights, as the authorized amounts currently exceed existing and projected demand within the planning horizon of this document. The developments in this area should be closely monitored in order to proactively protect NID's interests. The single biggest concern on the horizon will be the outcome of the PG&E contract negotiations and potential relicensing requirements.

5.3 WATER DEMAND

Estimated total annual system baseline demand (2007) was approximately 163,000 acre-feet (Table 4-5). This represents the total delivery volume (raw and treated water sales and required minimum flows) and system losses associated with delivery. Projecting the current system growth rates for raw and treated water, assuming future land use remains the same, results in a projected annual demand of 205,000 acre-feet by 2032 (Table 4-6).

In review of the water supply, it is also important to understand the timing of the demand. Approximately 75 to 80 percent of the District's demand occurs during the irrigation season, which totaled 120,879 acre-feet in 2007 (Table 4-5). In 2032, the modeled forecast for the irrigation season demand is 164,534 acre-feet (Table 4-6).

5.4 Evaluating Water Supply and Demand Over Time

The margin between average watershed runoff volume, which represents a majority of the District's water supply, and demand is diminishing and will continue to do so over time. Consequently, consideration of District practices regarding surplus sales, purchased contract water, and carryover storage will become increasingly more important over time. The same is true with changes that impact the natural runoff volume which could potentially result in either reductions in carryover storage, increased use of contract water, or both.

The Districts' water supply system is essentially a "store and release" system. The system of reservoirs stores snow melt and seasonal rains for release during the typically dry irrigation seasons. Current reservoir operations aim for all storages to be full at the end of the snow melt. During the summer period, demands are met by drawing from this reservoir storage volume. With all reservoirs full, and assuming no further inflow is available, the useable supply is 238,620 acre-feet (Table 5-2). Timing and distribution of the stored water will continue to be important considerations to the District going forward. The following sections discuss the potential impacts to reservoir operations.

5.4.1 Analysis of Future Reservoir Operation

Increased future demands will result in increased drawdown of District reservoirs. The following sections attempt to quantify the predicted future drawdown at the two lower division reservoirs. The analysis assumes that the District can operate such that the all of the impact from increased demands will be realized at either Scotts Flat Reservoir in the Deer Creek System or Rollins Reservoir in the Bear River System (Figure 3-2). When necessary, conservative assumptions were utilized to provide an analysis that provides a worst case assessment of future conditions.

5.4.1.1 Scotts Flat Reservoir (Deer Creek System)

Assessment of the impact on Scotts Flat Reservoir in response to future increases in demand is based on five important assumptions:

1. The next PG&E contract will be similar to the existing contract, which expires in 2013.
2. There will be no change in the operation of the upper division reservoirs.

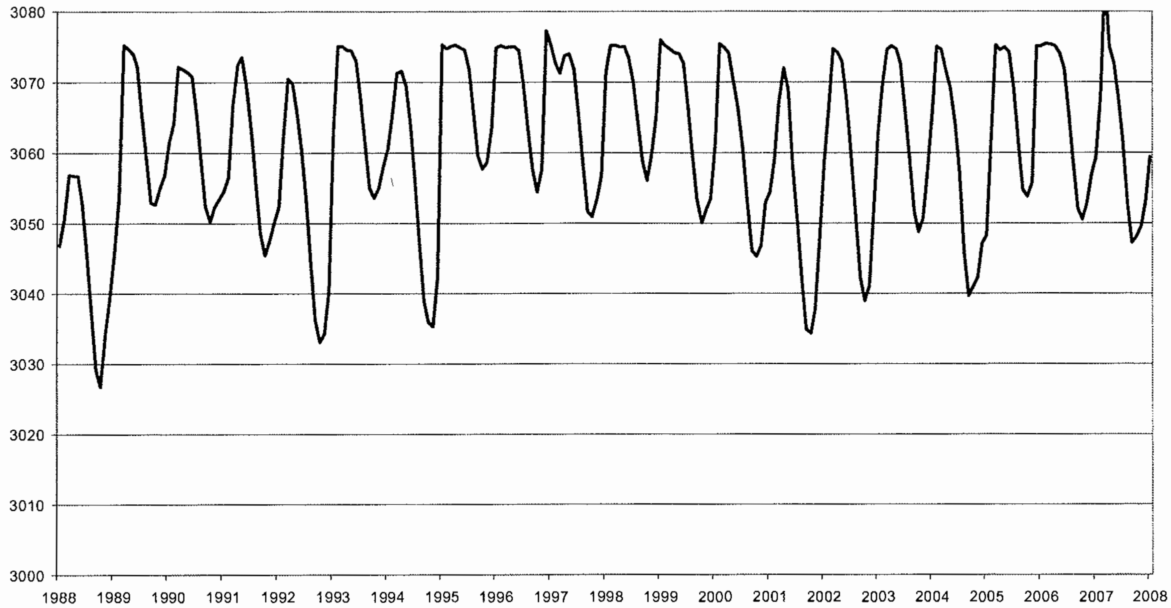
3. During the irrigation season, future South Yuba Canal imports will be used solely to make deliveries to the Cascade Canal.
4. The system will be operated such that the primary effect of increased water demand in the Deer Creek System will be increasingly lower water surface elevations at Scotts Flat Reservoir at the end of the irrigation season, over time.
5. The future water surface elevation in the reservoir can be predicted by using historic data from 1988–2007.

Using these assumptions, along with data developed as part of the RWMP Update and methods similar to those in the Banner/Cascade Pipeline Environmental Impact Report (EIR), the following analysis was performed to estimate the effect of projected demand on reservoir levels.

5.4.1.1.1 CAPACITY

Scotts Flat Reservoir has a total storage capacity of approximately 48,547 acre-feet at full pool (3074.8 feet msl) (Table 5-2). During the irrigation season, the reservoir is regularly drawn down 25 to 35 feet (between 3040.0 and El. 3050.0 feet msl), with refill occurring at the close of the irrigation season. Figure 5-2 illustrates historic reservoir levels for Scotts Flat Reservoir.

FIGURE 5-2. SCOTTS FLAT RESERVOIR ANNUAL ELEVATION (1988–2008)



5.4.1.1.2 CURRENT CONDITIONS

Assessment of current conditions regarding inflow, demand, and reservoir water levels within the Deer Creek System are based on the District's records and flow gage recordings for the years 1988 through 2007. Attention is focused primarily on water supply and demand during the summer irrigation season, which extends 183 days from April 15 through October 15, as this period represents the highest period of demand within the system and the lowest period of inflow. Note: The months May through October were used for the following calculations.

Inflow

Water flows into the Deer Creek System both above and below Scotts Flat Reservoir. For the purposes of this assessment, natural runoff is divided into inflows above Scotts Flat Reservoir and inflows below Scotts Flat Reservoir.

Inflow above the reservoir occurs from natural runoff into Deer Creek and from flows imported via the South Yuba Canal (per the Consolidation Contract with PG&E). The maximum annual volume of water the District may obtain via the South Yuba Canal[8] per contract with PG&E is 65,000 acre-feet (Jones and Stokes, 2006). During the period 1988 through 2007, the District received an annual average of 35,602 acre-feet (21,582 acre-feet annually during the summer irrigation season), or slightly more than half of the contract maximum, indicating that the District could import additional water if necessary.

During the same period, the average annual natural flow into Scotts Flat Reservoir was 34,229 acre-feet, of which 4,249 acre-feet occurs during the summer irrigation season (Table 5-4).

TABLE 5-4. AVERAGE ANNUAL NATURAL INFLOW TO SCOTTS FLAT RESERVOIR (1988–2007)

MONTH	AVERAGE NATURAL INFLOW (ACRE-FEET)
January	7,445
February	6,281
March	7,344
April	4,650
May	2,660
June	841
July	253
August	127
September	116
October	252
November	760
December	3500
SUMMER TOTAL (MAY–OCTOBER)	4,249
WINTER TOTAL	29,980
TOTAL	**34,229**

The volume of natural runoff into Deer Creek downstream of Scotts Flat Reservoir is estimated using data from the District's flow gages. The District maintains a gage downstream of Scotts Flat Reservoir (DC 125), as well as gages at the heads of five canals that are the primary diversions off of Deer Creek downstream of the reservoir: DS Canal (DC 145), Newtown Canal (DC 131), Tunnel Canal (DC 140), and Keystone Canal (DC 127). Average summer season

[8] The South Yuba Canal has a maximum capacity of 107 cfs.

flows for the gages are shown in Table 5-5. Using these gages, the average deficit flow[9] of water in Deer Creek from 1988–2007 during May through October was estimated to be approximately 9.45 cfs, or 3,430 acre-feet.

TABLE 5-5. AVERAGE IRRIGATION SEASON FLOW DATA DOWNSTREAM OF SCOTTS FLAT RESERVOIR (1988–2007)

GAGE	AVERAGE FLOW (CFS)	TOTAL VOLUME (ACRE-FEET)
Deer Creek downstream of Scotts Flat Reservoir (DC 125)	72.85	26,443
DS Canal Diversion (DC 145)	49.89	18,109
Newtown Canal (DC 131)	11.47	4,162
Tunnel Canal (DC 140)	19.80	7,188
Keystone Canal (DC 127)	1.14	414
TOTAL AVERAGE DEFICIT FLOW	**–9.45**	**–3,430**

The total average summer inflow for the Deer Creek is estimated to be 29,262 acre-feet annually, which represents the sum of inflow from the South Yuba Canal, natural inflow into Scotts Flat Reservoir, and natural inflow below Scott Flat Reservoir (Table 5-6).

TABLE 5-6. DEER CREEK SYSTEM AVERAGE INFLOW (1988–2007)

SOURCE	IRRIGATION SEASON INFLOW (ACRE-FEET)
Deliveries via South Yuba Canal	21,582
Natural Inflow to Scotts Flat Reservoir	4,249
Natural Inflow below Scotts Flat Reservoir	3,430
TOTAL INFLOW	**29,262**

Demand

Average irrigation season demand in the system during the 1988–2007 period was determined by summing the average flow at the head of the Cascade Canal, DS Canal, Newtown Canal, Tunnel

[9] Deficit flow is computed as the difference between water released from Scotts Flat Reservoir and water diverted at the head of the canal segments.

Canal, and Keystone Canal (Table 5-7). Winter demand has been constant at 15,100, which is not anticipated to change within the planning horizon of this document.

TABLE 5-7. DEER CREEK SYSTEM SUMMER IRRIGATION SEASON DEMAND SUMMARY (1988–2007)

GAGE	AVERAGE DEMAND (CFS)	TOTAL VOLUME (ACRE-FEET)
Cascade Canal (DC 102)	43.16	15,665
DS Canal Diversion (DC 145)	49.89	18,109
Newtown Canal (DC 131)	11.47	4,162
Tunnel Canal (DC 140)	19.80	7,188
Keystone Canal (DC 127)	1.14	414
TOTAL AVERAGE DEMAND FLOW	**125.46**	**45,538**

5.4.1.1.3 HISTORIC OPERATIONS AT SCOTTS FLAT RESERVOIR

Estimated inflow and water demand can be used to show how water use affects the volume of water available for use in Scotts Flat Reservoir during the summer irrigation season, when demand is typically highest. Total irrigation season demand (45,538 acre-feet) subtracted from summer inflow (29,262 acre-feet), yields 16,276 acre-feet (Table 5-8). This is the volume of water that must be supplied from Scotts Flat Reservoir storage to accommodate irrigation season demand.

The average volume of water available (1988–2007) in the reservoir in April is 47,126 acre-feet (3072.84 feet msl). With that starting volume, the predicted total volume of water remaining in the reservoir at the end of October is estimated to be 30,850 acre-feet (3047.32 feet msl). District records for the 1988–2007 period shows that the average end of month October storage in the Scotts Flat Reservoir was 30,507 acre-feet (3046.70 feet msl). The difference of the predicted vs. observed volumes is approximately 1 percent, indicating that the method outlined above can be used to accurately estimate reservoir storage.

5.4.1.1.4 FUTURE OPERATIONS

For the purposes of this analysis natural inflows into the system are considered constant. During the irrigation season, it is assumed that increased demands on the Cascade Canal will be met by importing additional water via the South Yuba Canal. Increased demands in the rest of the system will be made by using water stored in Scotts Flat Reservoir. Based on projections made with the updated model, annual irrigation season demand in the Cascade Canal is expected to increase from the 1988–2007 average of 15,665 acre-feet (43.16 cfs) to 24,668 acre-feet (67.96 cfs) in 2032, resulting in an additional import need of 9,003 acre-feet during the season (Table 5-9). Below Scotts Flat Reservoir, irrigation season demand is expected to increase from 29,873 acre-feet (82.30 cfs) to 41,720 acre-feet (114.94 cfs) in 2032, resulting in an increased demand of 11,847 acre-feet (Table 5-8). The volume of water that will need to be supplied from storage in Scotts Flat Reservoir to meet projected 2032 demand is estimated to be 28,143 acre-feet, an increase of approximately 42 percent.

TABLE 5-8. HISTORIC AND PROJECTED DEER CREEK IRRIGATION SEASON DEMAND SUMMARY (ACRE-FEET)

YEAR	INFLOW			DEMAND			VOLUME REQUIRED FROM STORAGE IN SCOTTS FLAT
	SOUTH YUBA	NATURAL	TOTAL	CASCADE CANAL	BELOW SCOTTS FLAT	TOTAL	
1988-2007 Average	21,582	7,680	29,262	15,665	29,873	45,538	16,276
2032 Projection	30,585	7,680	38,265	24,668	41,720	66,408	28,143
Change	9,003	0	4,594	9,003	11,847	20,870	11,867

As indicated above, the projected 2032 demand will result in an approximately 42 percent increase in irrigation season demand on the reservoir storage from historic (1988–2007) conditions. Assuming that Scotts Flat Reservoir begins the year at full pool (48,547 acre feet; 3074.80 feet msl), the drawdown to meet the projected demand deficit would result in an October pool of approximately 20,404 acre-feet (3026.50 feet msl). The net change in the water surface elevation of Scotts Flat Reservoir at the end of the irrigation season, between the historic (1988–2007) average and the 2032 prediction, is 20.2 feet.

Data from the updated model shows that the total projected 2032 winter (October 16–April 14) demand on the Deer Creek system is predicted to remain constant at 15,100 acre-feet. Historic average winter inflow to the reservoir totals approximately 44,000 acre-feet (14,020 acre-feet from PG&E plus 29,980 acre-feet of annual natural inflow above Scotts Flat Reservoir) (Table 5-9). Currently, releases from Scotts Flat (DC125) in the winter average 10,619 acre-feet (29.26 cfs).

TABLE 5-9. AVERAGE HISTORIC WINTER SEASON INFLOWS RETAINED IN SCOTTS FLAT RESERVOIR (1988–2007)

SOURCE	WINTER SEASON INFLOW (ACRE-FEET)
Deliveries via South Yuba Canal	14,020
Natural Inflow to Scotts Flat Reservoir	29,980
Releases from Scotts Flat Reservoir	–10,619
NET INFLOW	**33,381**

5.4.1.1.5 SUMMARY FOR SCOTTS FLAT RESERVOIR

For much of the winter the natural flow in Deer Creek below Scotts Flat is greater than NID's demand for water in the canals below the reservoir, so the majority of the demand for winter water is met by utilizing these natural flows. The net inflow of 33,381 acre-feet would be enough to offset the summer deficit of 28,143 acre-feet, and during an average year would refill the reservoir to full pool prior to the start of the irrigation season.

The accuracy of this approach is subject to the variations of the natural inflow volume and the irrigation season demand; however, it does provide insight into potential issues regarding future reservoir operation and deliveries for the Deer Creek system and the future water surface elevation of the Scotts Flat Reservoir.

5.4.1.2 ROLLINS RESERVOIR (BEAR RIVER SYSTEM)

Assessment of the impact on Rollins Reservoir levels resulting from the projected increases in District demand is based on five assumptions:

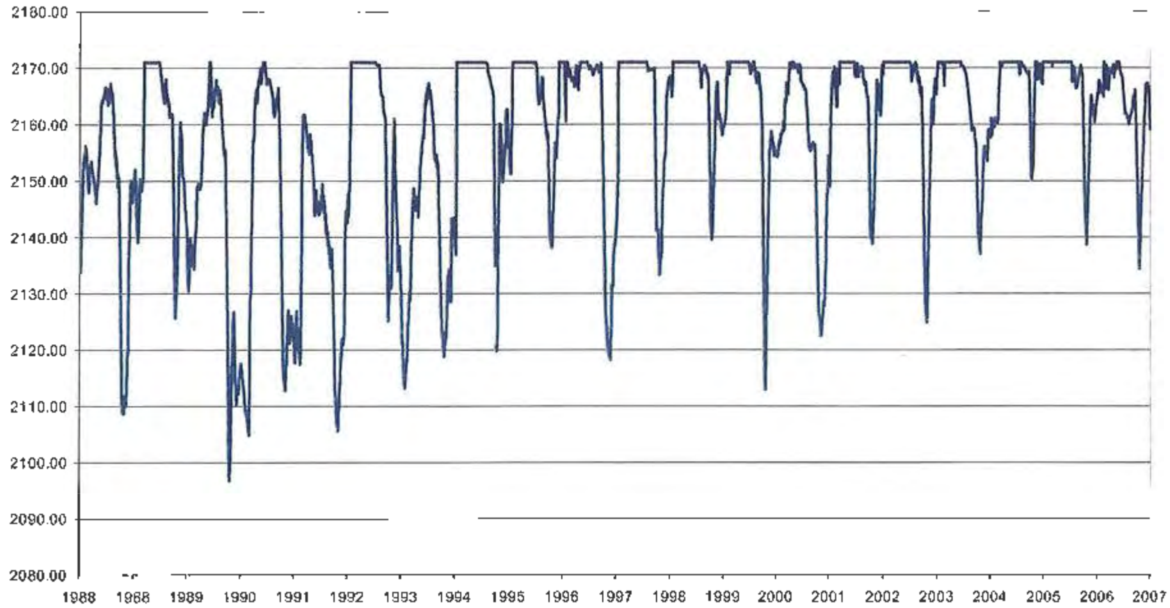
1. There will be no change in the operation of the upper division reservoirs.
2. The District will not change the operation of the Combie Reservoir.
3. The system can be operated so the primary effect of increased water demands on the Bear River System will be increasingly lower water surface elevations at Rollins Reservoir at the end of the irrigation season, over time.
4. The future water surface elevation in the reservoir can be predicted using historic data.
5. There will be no change in the PG&E Consolidated Contract purchase options (currently not fully utilized).

5.4.1.2.1 CAPACITY

Rollins Reservoir is the most significant regulating point for the Bear River system and has a total storage capacity of approximately 58,682 acre-feet at the full pool elevation (2171.0 feet msl) (Table 5-2). Historical data indicates that there is a slow drawdown of reservoir levels of between 5 and 10 feet over the summer irrigation period, followed by a more dramatic drawdown at the end of summer when the Drum Canal is taken out of service. The rapid annual fall drawdown is clearly visible in the plot of reservoir storage levels (Figure 5-3).

Review of reservoir levels for the period 1988 to 2007 indicates that reservoir storage has a typical annual drawdown of approximately 31 feet, to 2140.0 feet msl. However, there have been several years that the reservoir drawdown has approached 2120.0 feet msl—a drawdown of approximately 45 to 50 feet.

FIGURE 5-3. ROLLINS RESERVOIR ANNUAL ELEVATION (1988–2007)



5.4.1.2.2 CURRENT CONDITIONS

Current reservoir operations are subject to the Davis-Grunsky Grant Agreement, which requires that Rollins Reservoir levels be maintained at or above 2150.0 feet msl (50,700 acre-feet) for the period April 30–September 10 of each year for recreation purposes (subject to variation during extreme drought conditions). The Agreement is set to expire in 2013 and the District does not anticipate that it will be renewed. The current operation also includes allowing PG&E to utilize up to 30,000 acre-feet of capacity for reregulation of PG&E-imported water.

The complexity of the Bear River system, and the lack of required data (i.e., gage data, data on natural and other inflow, etc.), make a rigorous evaluation of the water surface elevation of Rollins Reservoir impractical. A more simplified approach to estimating the water surface elevation than was developed for the Deer Creek system follows. The analysis makes conservative assumptions when necessary to predict the water surface elevation in Rollins Reservoir.

Inflow

Rollins Reservoir receives water from two sources: import water via the Drum Canal and natural runoff from the contributing Bear River watershed. The average annual natural inflow from the Bear River into Rollins Reservoir is estimated to be approximately 173,000 acre-feet[10] .

The Drum Canal is the primary means of supplying water to the reservoir during the late summer periods. During these months, PG&E and NID generally divert all Drum flows, as well as all natural flows, through the Bear River Canal immediately downstream of the reservoir.

The system as a whole also receives inflow from a variety of sources including Auburn Ravine, Orr Creek, Coon Creek and the City of Auburn Wastewater Treatment Plant. These inflows reduce the demand on Rollins Reservoir; however, due to the current location of flow gages in the system, these flows are not considered in this analysis as they cannot be accurately quantified. It is recommended that the District investigate locating gages at these sites to better quantify flows in the future.

Demand

Total Bear River System demand in 2007 was based on the sum of the following gages: head of the Combie Phase I Canal, PG&E deliveries from the Fiddler Green Canal, Rock Creek Reservoir, Wise Canal, and environmental flows below Combie Reservoir (Table 5-10). Data show that the District's Bear River distribution system had a 2007 irrigation season demand of approximately 73,813 acre-feet (Table 4-5).

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[10] Data provided by PG&E for the period 1975–2008.

TABLE 5-10. BEAR RIVER SUMMER IRRIGATION SEASON DEMAND SUMMARY (2007)

GAGE	AVERAGE DEMAND (CFS)	TOTAL VOLUME (ACRE-FEET)
Combie Phase I	102.38	37,163
Fiddler Green Delivery	10.48	3,804
Rock Creek Reservoir	25.19	9,144
Wise Canal	65.30	23,702
TOTAL AVERAGE DEMAND FLOW	**203.35**	**73,813**

Between 1988 and 2007, the average volume of water available in the reservoir at the end of the irrigation season was 43,684 acre-feet (2139.87 feet msl).

5.4.1.2.3 FUTURE OPERATIONS

Two primary water demands will result in increased summer drawdown of Rollins Reservoir: increased diversions to the Deer Creek system via the South Yuba Canal to meet future demands, and increased demand in the Bear River system.

For the purposes of this evaluation, it is assumed that the flows in the Drum Canal are reduced by 9,003 acre-feet during the irrigation season to offset the increased demand on the Deer Creek system (as discussed above). The end result will be a reduction of inflows to Rollins Reservoir.

The Bear River system's estimated 2032 demand is projected by the updated model to increase by 24,333 to 98,141 acre-feet (Table 5-11).

TABLE 5-11. ROLLINS RESERVOIR IRRIGATION SEASON DEMAND SUMMARY (ACRE-FEET)

	CURRENT DEMAND (2007)	PROJECTED DEMAND (2032)	INCREASE IN DEMAND
Bear River System	73,813	98,141	24,334
Deer Creek System		9,003	9,003
TOTAL		**107,144**	**33,337**

The increase in demand combined with the anticipated additional diversions to the Deer Creek system results in a total 2032 Bear River system irrigation season demand of 107,144 acre-feet, an increase of 33,337 acre-feet (Table 5-11). Assuming that the historic end of summer water surface volume at Rollins Reservoir is drawn down by an additional 33,337 acre-feet, the resulting storage will be 10,347 acre-feet (2056.43 feet msl). The net change in the end of summer water surface elevation of Rollins Reservoir, between the 1988–2007 average and the 2032 prediction, is 83.44 feet. This analysis is difficult to accurately perform due to the Consolidated Contract provision that allows PG&E to utilize capacity in Rollins, which has been in place since the construction of Rollins. It is challenging at best to determine what Rollins Reservoir's historical storage would have been, absent PG&E. Because the present operation is a result of both entities drawing from the reservoir rather than if all the capacity had been the District's, the method used in this analysis is conservative.

Projections from the updated model show that the total projected 2032 winter demand on the Bear River system is predicted to be 17,846 acre-feet. The total annual demand on the system, including the decrease in summer imported water resulting from the increased diversion to the Deer Creek system, is expected to total 124,990 acre-feet. As stated above, the annual natural inflow to Rollins Reservoir is approximately 173,000 acre-feet.

5.4.1.2.4 SUMMARY FOR ROLLINS RESERVOIR

Based on the volume available, and considering the District's storage/diversion water rights for the Bear River, the District should be able to refill Rollins Reservoir from the winter inflows, in all but low flow years. During the summer, when there is little natural runoff, increases in irrigation season demand will result in increased demand on storage and greater reservoir drawdowns.

5.4.1.3 RESERVOIR SUMMARY

The data shows that, in the future, meeting the increases in raw water demand during the summer season will result in greater drawdowns in the supply reservoirs, particularly Scotts Flat and Rollins Reservoirs. Competing uses of the reservoirs may become a future issue for the District.

5.5 WATER SHORTAGES

Table 5-12 summarizes NID's water supply sources and deliveries from 2005 through 2009. Runoff for the 2001 water year was the second lowest on record, the lowest on record being the

1976–1977 water year with a recorded runoff of approximately 34,864 acre-feet. The three driest years in a row remain the 1990–1992 water years. While the 2001 water year had one of the lowest runoff volumes recorded, the District was able to meet system demand by supplementing the runoff volume with carryover storage and reducing water releases for power generation. However, multiple, consecutive below-average water years will result in a need for careful, proactive management in order to continue meeting system demand.

TABLE 5-12. WATERSHED SUPPLY AND DELIVERIES (ACRE-FEET PER WATER YEAR)

	Year				
	2005	**2006**	**2007**	**2008**	**2009**
Watershed Runoff[1]	269,375	423,457	132,488	145,825	205,800
Carryover Storage[2]	112,557	145,624	135,181	117,767	107,859
Contract Purchases[3]	5,277	5,455	12,065	7,685	6,033
Recycled	3,025	3,134	2,545	2,442	2,550
Total Supply	**390,234**	**577,670**	**282,279**	**273,719**	**322,242**
Total Demand[4]	**175,659**	**175,957**	**167,242**	**N/A**	**N/A**
Supply shortage	**0**	**0**	**0**	**0**	**0**

1 Includes Scotts Flat, Bowman, and Jackson Meadows natural inflow and Texas-Fall Creek Diversions.
2 Storage recorded at the end of September of the previous year and reduced by unusable pool of 39,675 acre-feet.
3 Purchased under PG&E contract. Includes contract B-9 (Deer Creek), B-12 (Rock Creek), B-12 (Wise)
4 Demand excludes flows used for power generation and assumes losses of 15 percent plus environmental flows of 7,700 acre-feet.

As demand increases in the future, the potential for supply shortages increases, resulting in the potential for more frequent implementation of drought measures. Drought analysis conducted for this report, detailed below, indicates that the District has sufficient supply to cover a single dry year. Multiple dry years would most likely result in implementation of the District's drought management measures (Section 6.3). To assess the District's ability to meet system demands during such a scenario, a drought analysis was conducted to determine the availability of water supply during two hypothetical drought scenarios, based on the driest three-year period of record, 1990 through 1992. This evaluation provides an indication of the District's ability to meet existing and projected 2032 demand and the effectiveness of the demand management tools available to the District in their Drought Contingency Plan.

Table 5-13 and Table 5-14 show NID's system operations during the historic worst three-year drought period (1990–1992), and assumes three conditions: 1) existing demand, 2) estimated 2032 demand, and 3) that a three year drought follows an average runoff year. Total supply is identified, followed by total demand, and modified according to the District's current drought contingency conservation guidelines. The carryover storage was assumed to be the difference between the previous year's supply and demand. Contract purchases are assumed to remain the same as current purchases unless water supplies drop below 233,000 acre-feet, the supply availability trigger for the Drought Contingency Plan, and carryover storage approaches the minimum target level of 78,000 gross acre-feet (38,325 acre-feet useable).

TABLE 5-13. HISTORIC WORST 3-YEAR DROUGHT WITH EXISTING DEMANDS

	Average	Hypothetical Drought		
	Year	**Year-1**	**Year-2**	**Year-3**
Watershed Runoff[1]	237,600	140,824	138,469	100,874
Carryover Storage[2,3]	107,300	107,300	96,524	83,393
Contract Purchases[4]	8,000	8,000	8,000	23,591
Recycled[5]	3,400	3,400	3,400	3,400
Total Supply	**356,300**	**259,524**	**246,393**	**211,258**
Drought action stage	I (0%)	I (0%)	I (0%)	11 (15%)
Total Demand with reduction[6,7,8]	**163,000**	**163,000**	**163,000**	**138,550**
Shortage with reduction	0	0	0	0

1 Assumed 1990–1992 watershed runoff.
2 Carryover storage is average annual carryover storage reduced by unusable pool of 39,675 acre-feet.
3 Carryover Storage is the remainder of the difference between total supply and total demand of the previous year. Zero carryover storage means the unusable pool of 39,675 acre-feet remains.
4 Hypothetical drought shows no demand reduction and no need to increased purchased volume. Contract conditions with PG&E establish maximum dry year purchases of up to 23,591 acre-feet. This is subject to contract renewal with PG&E. In typical climate conditions, NID purchases an average of 7,000 acre-feet per year from PG&E. The contract purchased volume is set to the current average.
5 Assumed constant recycled water supply.
6 Existing agricultural, municipal, institutional, and environmental demands; does not include releases for hydropower generation.
7 Reduced by water shortage contingency plan demand reduction goal.
8 Drought values differ slightly from those within the District's 2010 UWMP due to differences in years used for analysis.

Table 5-13 shows that the District currently has sufficient water supplies to satisfy existing demand without declaring a drought emergency and implementing demand reductions identified in the Drought Contingency Plan. Although the noted process is feasible, it is suggested that some drought contingency measures be implemented in years 1 and 2 to maintain higher carryover storage numbers in the event there is the drought extends into a fourth year. Power generation would be minimized during the dry years to assure water availability for consumptive uses, the District's primary goal.

TABLE 5-14. HISTORIC WORST 3-YEAR DROUGHT WITH 2032 DEMANDS

	Average	Hypothetical Drought		
	Year	**Year-1**	**Year-2**	**Year-3**
Watershed Runoff[1]	237,600	140,824	138,469	100,874
Carryover Storage[2,3]	107,300	107,300	54,344	45,401
Contract Purchases[4]	8,000	8,000	23,591	23,591
Recycled[5]	3,400	3,400	3,400	3,400
Total Supply	**356,300**	**259,524**	**219,804**	**173,266**
Drought action stage	I (0%)	I (0%)	II (15%)	IV (35%)
Total Demand with reduction[6,7,8]	**205,180**	**205,180**	**174,403**	**133,367**
Shortage with reduction	0	0	0	0

1 Assumed 1990–1992 watershed runoff.
2 Carryover storage is average annual carryover storage reduced by unusable pool of 39,675 acre-feet.
3 Carryover Storage is the remainder of the difference between total supply and total demand of the previous year. Zero carryover storage means the unusable pool of 39,675 acre-feet remains.
4 Assumed maximum dry year purchase of 23,591 acre-feet, subject to contract renewal by PG&E.
5 Assumed constant recycled water supply.
6 Projected 2032 agricultural, municipal, institutional, and environmental demands; does not include releases for hydropower generation.
7 Reduced by water shortage contingency plan demand reduction goal.
8 Drought values differ slightly from those within the District's 2010 UWMP due to differences in years used for analysis.

Assuming the historic worst three year drought, Table 5-14 shows that, with the 2032 demand, the District would need to declare increasing drought action stages as the hypothetical drought continued. Early action would help reduce the required cutback in demand. In the third year, cutbacks of 30 to 35 percent reduction in demand would be required to continue to provide services throughout the year while maintaining the minimum desired carryover storage. As shown in Table 5-14, a reduction of 35 percent in system demand would slightly exceed the minimum carryover storage requirement.

Table 5-15 and Table 5-16 present an analysis of a hypothetical extreme drought where only 50 percent of the runoff during the historical three-year drought under current conditions and the

2032 forecast demand. When water supplies were reduced by half, implementation of the Drought Contingency Plan, as summarized in Section 6.3, would be required.

TABLE 5-15. EXTREME HYPOTHETICAL DROUGHT WITH EXISTING DEMANDS

	Average	Hypothetical Drought		
	Year	**Year-1**	**Year-2**	**Year-3**
Watershed Runoff[1]	237,600	70,412	69,235	50,437
Carryover Storage[2,3]	107,300	107,300	66,153	56,429
Contract Purchases[4]	8,000	8,000	23,591	23,591
Recycled[5]	3,400	3,400	3,400	3,400
Total Supply	**356,000**	**204,703**	**162,379**	**133,857**
Drought action stage	I (0%)	II (15%)	IV (35%)	V (50%)
Total Demand with reduction[6,7,8]	**163,000**	**138,550**	**105,950**	**81,500**
Shortage with reduction	0	0	0	0

1 Assumed 50 percent reduction of the 1990-1992 watershed runoff.
2 2004 carryover storage is average annual carryover storage reduced by unusable pool of 39,675 acre-feet.
3 Carryover Storage is the remainder of the difference between total supply and total demand of the previous year. Zero carryover storage means the unusable pool of 39,675 acre-feet remains.
4 Assumed maximum dry year purchase of 23,591 acre-feet, subject to contract renewal by PG&E
5 Assumed constant recycled water supply.
6 Existing agricultural, municipal, institutional, and environmental demands; does not include releases for hydropower generation.
7 Reduced by water shortage contingency plan demand reduction goal.
8 Drought values differ slightly from those within the District's 2010 UWMP due to differences in years used for analysis.

As shown in Table 5-15, assuming current demand conditions, a reduction of 15 percent would be implemented in the first year as set forth in the Drought Action Stage III for years when the total supply, excluding PG&E purchases, is less than 198,000 acre-feet. With demand reduced by 15 percent in the first year, sufficient carryover storage with a buffer of approximately 27,000 acre-feet would be available in year 2. In year 2, demand would need to be reduced further (estimated at 35 percent) to provide the desired carryover storage for year 3. In year 3, reductions in demand would approach 50 percent in order to maintain the carryover storage. In each case, these estimated reductions in demand are conservative, allowing for a slight buffer in the carryover storage as a contingency.

TABLE 5-16. EXTREME HYPOTHETICAL DROUGHT WITH 2032 DEMANDS

	Average	Hypothetical Drought		
	Year	**Year-1**	**Year-2**	**Year-3**
Watershed Runoff[1]	237,600	70,412	69,235	50,437
Carryover Storage[2,3]	107,300	107,300	30,300	23,936
Contract Purchases[4]	8,000	23,591	23,591	23,591
Recycled[5]	3,400	3,400	3,400	3,400
Total Supply	**356,300**	**204,703**	**126,526**	**101,364**
Drought action stage	I (0%)	II (15%)	V (50%)	V (50%)
Total Demand with reduction[6,7,8]	**205,180**	**174,403**	**102,590**	**102,589**
Shortage with reduction	0	0	0	**–1,225**

1 Assumed 50 percent reduction of the 1990-1992 watershed runoff.
2 2004 carryover storage is average annual carryover storage reduced by unusable pool of 39,675 acre-feet.
3 Carryover Storage = remainder of the difference between total supply and total demand of the previous year. Zero carryover storage means the unusable pool of 39,675 acre-feet remains.
4 Assumed maximum dry year purchase of 23,591 acre-feet subject to contract renewal with PG&E in 2013.
5 Assumed constant recycled water supply.
6 Projected 2027 agricultural, municipal, institutional, and environmental demands; does not include releases for hydropower generation.
7 Reduced by water shortage contingency plan demand reduction goal.
8 Drought values differ slightly from those within the District's 2010 UWMP due to differences in years used for analysis.

For the analysis of the extreme drought scenario, assuming estimated 2032 demand, extreme water conservation measures would be required. A Drought Action Stage V (50 percent reduction) would need to be declared in the second and third years of this extreme drought scenario. The analysis indicates that even with a 15 percent reduction in demand in year 1, the carryover storage does not reach desired levels. To prevent a shortfall as shown in year 3, a reduction of up to 25 percent in demand would need to be made in year 1. It is clear from these analyses, that monitoring and maintaining carryover storage is a critical component of drought planning as well as early implementation of drought conservation measures

5.6 SUMMARY

In 2032, excluding the natural runoff from the Bear River into Rollins Reservoir, the projected consumptive demand (205,180 acre-feet) is expected to approach the average annual runoff volume from the District's watersheds (237,600 acre-feet). Assuming average usable carryover storage of 107,300 acre-feet, the District would have sufficient water to meet its annual demand without restrictions. It has also been determined that supply would be sufficient to address a single dry year without restrictions. In a continued drought of more than one year, as the drought scenarios indicate, the District cannot meet future total demands during a multi-year drought without enacting the drought contingency plan early on.

Currently, a drought condition exists if the total available water supply, including carryover storage, is 210,000 acre-feet or less (NID, 2007). At this inflow volume, all demands are met, including the minimum carryover storage requirement. The net effect of the increase in demand is that drought management operations would occur more often, and earlier, and greater conservation measures would need to be implemented so as to provide greater reductions in water demand.

It is suggested that drought planning be based on more factors than just total supply. For example, if natural inflow falls below 50 percent of the average annual supply of 354,625 acre-feet (to 177,300 acre-feet), and/or the ratio between runoff and the normal carryover storage (107,300 acre-feet) is less than 50 percent, the District should consider initiating drought measures. Early action through the use of the drought contingency plan will smooth out the future reductions in deliveries. Further, as discussed in Section 7.0, voluntary conservation should become the norm rather than initiated at Stage 1 drought conditions.

6.0 WATER MANAGEMENT

The District manages a complicated water storage system that extends from the crest of the Sierra Nevada mountain range to the Central Valley. The primary sources of water consist of snowmelt which is captured and stored in a series of reservoirs. As demand within the District increases, events such as drought and climate change will create new and ever-increasing challenges as the District strives to maintain a sustainable system into the future.

6.1 WATER SUPPLY

The District's water system is a network of ten major reservoirs, 425 miles of canal, and 300 miles of pipeline, as described in Section 3.0. The District's Yuba-Bear system is operated in conjunction with PG&E's Drum-Spaulding system, which are currently undergoing a joint relicensing process through FERC. NID and PG&E established a water management committee (Committee) that meets regularly to coordinate reservoir and canal system operations. The Committee established the following four major operational objectives:

1. Operate NID's system in conjunction with PG&E's Drum-Spaulding system to maximize the use of water for power generation and consumptive use, and minimize spillage.
2. Consumptive needs and regulatory requirements are given the highest priority; power generation and recreation are given a lower priority.
3. Operate to maximize reasonable and beneficial uses within NID's water rights.
4. Fulfill all requirements of contracts/agreements (PG&E, PCWA, CDFG, SWRCB, FERC, customers, special agreements, etc.).

Following these objectives, the Committee coordinates reservoir operations and canal flows of the Yuba-Bear Project with the Drum-Spaulding Project. Flow rates are determined by assessing projected consumptive need, contractual obligations, and current hydrological conditions. The Committee's goal is to fill all reservoirs during the runoff period, have zero spill, and end the year with adequate carryover storage to prevent shortages the following year.

The Committee uses several tools to meet the operational objectives. Using the following tools, NID collects data and compares this information to data developed by the other entities:

- Snow Survey data—NID has six snow courses[6] and surveys are conducted February 1, March 1, April 1, and May 1 (June if needed)
- Runoff forecasts—Forecasts using the snow survey data are produced by NID and compared with PG&E's and the Department of Water Resources' (DWR) forecasts for the watershed
- Historical databases are maintained for runoff, end of month reservoir storage, precipitation, snow water content, and flow data.
- SNOTEL[7] data from nearby areas
- Gage data—stream flow, canal flow, reservoir storage (real time and historic)
- District sales records
- PG&E contract
- PG&E model output
- CDFG agreement
- Water right license conditions
- Staff professional experience

Through the use of these tools and data sources, the Committee makes decisions on how to operate the system to maximize the project's benefits while keeping a watchful eye on retaining sufficient water in storage to meet anticipated consumptive uses during the rest of the year and for the following year. Week to week decisions are predicated on current watershed conditions and the results of the updated PG&E annual operations model. Since enacting the current operating criteria in 1991, NID has not had to curtail deliveries to its raw and treated water customers.

6.2 WATER DEMAND

As outlined in Section 4.0, the current District demand totals 163,000 acre-feet of water (Table 4-5). The demand analysis indicated that in 2032, the total District demand will have increased to approximately 205,180 acre-feet per year (Table 4-6). Data indicates that approximately 80 percent of the District's annual demand is made up of raw water/agricultural demand during the irrigation season. Although there have been fluctuations in the raw water services, based on historical land use data, agricultural demand is expected to remain the predominant water demand within the District.

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[6] An established line, usually from several hundred feet to as much as a mile long, traversing representative terrain in a mountainous region of appreciable snow accumulation; along this course, measurements of snow cover are made to determine its water equivalent.
[7] In remote areas of the western United States, SNOTEL (snow telemetry) sites, typically comprising a snow pillow, a shielded standpipe storage precipitation gauge, and a radio transmitter, are used to telemeter precipitation data to a satellite.

6.3 DROUGHT CONTINGENCY PLAN

In December 1992, NID adopted a drought contingency plan identifying five stages of water supply shortages and actions to be taken that would enable NID to meet its operational objectives under each stage of drought. The plan was updated in June 2007 to clarify drought planning steps and include additional drought contingencies at various stages of drought. Table 6-1 shows the five stages based upon the April 1st forecast and the demand reduction goal associated with each stage.

As discussed in Section 5.5, the District has sufficient water reserves to handle a single year drought with essentially no reduction in deliveries. However, in keeping with the concerns surrounding the effects of climate change, it is likely that future dry periods could extend over several years at a time. As such, it is suggested that the District initiate drought contingencies based on projected annual runoff instead of the current practice of seasonal snowpack assessment. While the snow melt is a key component of the water supply, analysis of the snowpack only provides a qualitative indication as to the potential supply. Annual runoff figures would include rain events and other sources of supply providing a more complete assessment of the hydrologic condition (i.e., drought).

It is clear that maintaining the minimum carryover storage volume is a key factor in minimizing impact on deliveries during extended dry periods. As a result of the Phase I effort, the District increased the minimum value for carryover storage to 78,000 acre-feet. In light of the data collection, demand projections, recent climate change reports, and analyses undertaken for Phase II of the RWMP, it is recommended that increasing the minimum value for carryover storage be examined once again. Further, conservation should be part of daily/normal operations moving into the future as it will be a key component of achieving a sustainable supply.

Table 6-1 summarizes the current drought contingency plan triggers and the anticipated operative actions. It is recommended that these be reviewed on a regular basis (every five years) to determine if the levels and actions remain appropriate, in particular regards to the minimum volume of carryover storage.

TABLE 6-1. WATER RATIONING STAGES AND REDUCTION GOALS

Stage	April 1st Available Supply (acre-feet)	Supply Shortage (percent)	Type of Rationing Program	Demand Reduction Goals (percent)
I	233,000	None	Normal Operation	0
II (Alert)	210,000	10-15	Voluntary	15
III (Warning)	198,000	15-25	Mandatory	25
IV (Emergency)	175,000	25-35	Mandatory	35
V (Critical)	152,000	35-50	Mandatory	50

Stage I: Normal Water Conditions

1. District will make full supply and contract deliveries.
2. Continue to operate and maintain the water system in an efficient and economical manner.
3. Continue to advise District customers of water conditions and District conservation measures.
4. Routinely evaluate and update water conservation and system storage plans.

Stage II: Drought Alert — 10 to 15 Percent Shortage

1. District leak repair receives high priority.
2. Strongly encourage customers to conserve water.
3. Restaurant owners requested not to serve water unless requested by customers.
4. Declare that no District surplus water is available.
5. Maintain 25 percent of historical end of month October storage for carryover.
6. Limit fire department practice drills and flow testing of fire hydrants.
7. Institute additional agricultural efficiency practices to assist the agriculturalist in proper water management as outlined in the Agricultural Water Management Plan.
8. Limit residential, garden, and landscape irrigation during the hottest portion of the day (10:00 a.m. to 6:00 p.m.).

Stage III: Drought Warning – 25 Percent Shortage

1. All of Stage II requirements above, except item 5, and the following:
2. Reduce untreated water deliveries by 25 percent and impose irrigation season delivery alternatives.
3. Encourage all treated water-metered school grounds and all other public grounds to reduce water usage by 15 percent from what they received under Stage I conditions, as outlined in the District's Urban Water Management Plan.
4. Implement strong conservation pricing on treated water.
5. Prohibit new treated water services from planting new plant lawns, landscaping, or gardens. Encourage customers to use efficient irrigation systems.
6. Maintain at least 78,000 minimum acre-feet in storage at the end of October.

Stage IV: Drought Emergency – 35 Percent Shortage

1. Implement all items under Stages II and III, and the following:
2. Reduce untreated water deliveries by 35 percent and impose irrigation season delivery alternatives.
3. Suspend all new untreated water sales.

Stage V: Critical Drought Emergency – 50 Percent Shortage

1. Implement all items under Stages II, III, and IV, and the following:
2. Reduce untreated water deliveries by 50 percent and impose irrigation season delivery alternatives.
3. Establish conservation oriented rate structures and pricing methods to encourage water conservation.

6.4 CLIMATE CHANGE AND SYSTEM SUSTAINABILITY

Climate change and sustainability are two critical topics requiring attention by District managers for successful water management into the future. There is a substantial body of literature on models and projections of the impact/effect of climate change on water resources. California has been a leader in the area of climate change, sponsoring numerous studies regarding the potential future impacts of climate change.

While there are many varied opinions in regards to timing, most of the studies reviewed agree on several points: The State of California Climatologist, in a report dated 2009 (DWR, 2009g), has noted:

- The mean annual temperature will increase from 2 to 6 degrees C. It is noted however, that the terrain will result in local variations. The points of consensus are that the temperature will rise by up to approximately 5 degrees (F) by 2050
- There will be a decrease in the snow pack in the Sierra Nevada Mountains as a result of the temperature increase.
- Precipitation events will be more intense, resulting in the potential for higher flood peaks.
- The increased intensity will result in greater variation in flows—higher spring flows and lower summer flows.
- Extended drought periods will occur more frequently.

All studies emphasize the importance for immediate response from regulatory and water service agencies to begin planning and take action for future conditions.

6.4.1 CLIMATE CHANGE

A review of the pertinent available literature in regards to climate change and its resulting impact was done with particular attention to California and the Sierra Nevada's. As mentioned above, the California DWR has been a leader in climate change research and the impact of climate change on the California water supply (Figure 6-1). DWR has commissioned or been part of numerous studies which have culminated in the data and recommendations presented in the climate change section of the California Water Plan, Update 2009. It is noted however, that the bulk of the research in regards to climate change has been focused on water supply and ecological restoration. It is recognized that there is a substantial amount of additional research needed in regards to issues such as drought extent and frequency and flood frequency data. Research is ongoing and the models that have been developed and calibrated are being used for more in-depth analyses, which are planned for release in the 2013 Water Plan update.

Research into the aspects of climate change by the DWR has arrived at six basic conclusions, four of which are of interest to NID:

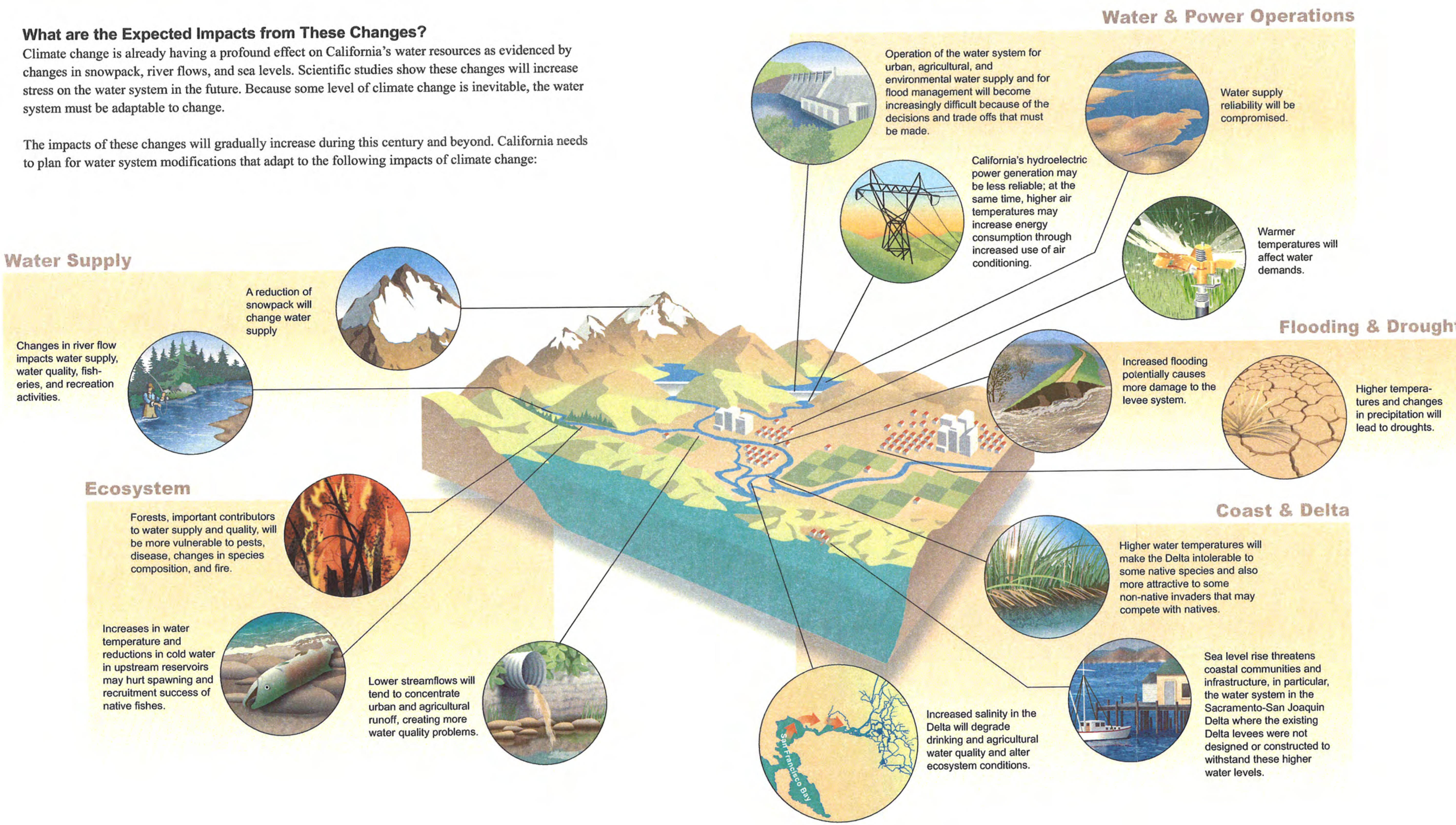
First, it is widely accepted that the average annual temperatures are increasing. As presented in the DWR 2009 update of the California Water Plan, t over the last 100 years the average annual temperature in California has risen approximately 1.5 degrees Fahrenheit (F). It is projected that the mean annual temperature will increase up to 5 degrees F by 2050, although California's widely varied topography will create substantial local variations (DWR, 2010b). The impact of such changes will likely include increased water demand during the irrigation season, resulting not only from warmer temperatures, but also from longer growing seasons, earlier and faster snowmelt in the spring, increased evapotranspiration, and changes to the overall ecosystem (i.e., vegetation changes, forest migration, etc.).

Climate Change: *Stressing Our Water Systems*

What are the Expected Impacts from These Changes?

Climate change is already having a profound effect on California's water resources as evidenced by changes in snowpack, river flows, and sea levels. Scientific studies show these changes will increase stress on the water system in the future. Because some level of climate change is inevitable, the water system must be adaptable to change.

The impacts of these changes will gradually increase during this century and beyond. California needs to plan for water system modifications that adapt to the following impacts of climate change:



As a result of the past century's temperature increase of 1.5 degrees Celsius, the snow pack in the Sierras on average has decreased approximately 10 percent over the last 100 years. Further, climate patterns are becoming more variable. The DWR research has concluded that the average snow pack will decline from between 25 to 40 percent by mid century. Although the total annual precipitation will remain relatively unchanged, the intensity of the wet and dry periods will increase. In the current State Water Plan, the DWR has taken a pro-active position to secure a sustainable water supply for the future and outlined recommendations for strategic goals as well as near- and long-term actions that will assist water managers in sustaining their water resources.

The second conclusion is that while impact to total annual precipitation is uncertain, there will be a noticeable increase in extreme conditions, meaning greater flood events and longer and more intense drought conditions. Storm events are predicted to be more severe, resulting in increased runoff during these events. In the report "Climate Change in Lake Tahoe Basin", 'peak snowmelt in the Upper Truckee River will occur four to six weeks earlier of the century'. This will be a significant factor in the operational planning of reservoir management.

The third conclusion is of particular importance to the District due to its heavy reliance on snow melt for supply and refill of its storage systems. It is predicted that there will be a decreasing snowpack in the northern Sierras. More precipitation is expected to fall as rain in the higher elevations, resulting in more intense runoff events (i.e. shorter duration with higher peak flows). The potential for reservoir spillage, and consequently, water loss, may increase as a result. Future planning should consider the feasibility of increasing existing storage capacities in existing reservoirs or construction of new storages.

The final conclusion is that snowmelt will occur earlier in the season, thereby shifting the timing of the annual runoff. This factor, combined with more rain events than snow, will necessitate a shift in reservoir draw and refill cycles. Further, in order to minimize spillage and ensure the reservoirs are full prior to the beginning of the irrigation season modifications to current operating policies will need to be developed and enacted.

Another literature source reviewed for this analysis was the recent UC Davis study titled "The Effects of Climate Change on Lake Tahoe in the 21st Century: Meteorology, Hydrology, Loading and Lake Response." This study is particularly applicable as the Lake Tahoe watershed is adjacent the District's own watershed. While in general agreement with the assessments made in the California Water Plan, they provide a more specific timeline in regards to the projected watershed changes.

In this report, they note an increase in temperature resulting in a continued shift from snowfall to rain, and earlier snowmelt and runoff during the water year. Currently, 50 to 60 percent of the annual precipitation above 6000 feet falls as snow. Research done as part of this study has predicted this rate to drop to 30 to 40 percent. Further, they have concluded that the duration of the snowpack will be reduced from 248 days to 184 days by the end of the century. Inflows from natural runoff are also predicted to decline with time.

The implications of this shift will increase the frequency and magnitude of flow events. Increased magnitude of flood flow events results in impacts to both flow management and water quality, as the increased flows will pick up more nutrients as well as sediments. As such, storm water runoff and storm water management will become increasingly important considerations in regards to capturing storm runoff, water quality and treatment, and future land management practices. The District will need to review land development practices and work with state, county and local government agencies to implement more stringent land management practices to address future water quality issues.

It is also well-accepted that climate change will impact water demands. The DWR report noted that while climate change appears to have a somewhat lesser impact on future water demand than population growth; it will still be a significant factor in future demand (DWR, 2010b). Further, climate change could potentially offset reductions achieved by implementation of agricultural and urban conservation measures, making such measures that much more important for water resource sustainability.

Including the impacts of climate change is a key consideration in the future operational planning of water resource systems. Traditionally, historical trends and observations have been the basis for water resource planning. At the District, the annual water budget is typically set based on the April snow survey, upon which allocations and deliveries for the year are planned and put into motion. Today, climate change is forcing managers to reevaluate these "tried and true" management strategies. Acceptance that change is occurring and proactive planning for those changes will help the District adapt.

6.4.2 SUSTAINABILITY

Sustainability is defined as the capacity to endure. With respect to the District's water system, sustainability can be defined as the maintenance of supply, or the assurance that there will be sufficient supply in the future. The most widely quoted definition of sustainability is from the Bruntland Commission of the United Nations, which defined sustainability as "...being able to meet the needs of the present without compromising the ability of future generations to meet their needs."

The most immediate and readily apparent action the District can take to promote a sustainable water supply is to establish conservation measures for itself and for its customers to reduce the volume of water use. Other sustainability measures include developing policies and regulations to guide land use practices within the contributing watershed. Land use practices impact supply, water quality, and sedimentation.

The District has implemented a variety of conservation measures and established policies that will assist the District in meeting sustainability goals. Plans and programs initiated by the District include its development of a Strategic Plan and Capital Improvement Plan which focus on conservation, education, and land use practices. These plans are constantly evolving based on conditions within the District. One of the challenges noted in California's Water Plan Update 2009 for the Mountain Counties region, in which the District lies, is to address conservation concerns regarding open ditch delivery systems. Such systems typically have high loss rates and high annual maintenance costs. Further, the open systems are subject to water quality issues such as degradation from local area runoff and potential spills of toxic materials such as oil, gasoline, and pesticides. As a majority of the District's raw water system utilizes an open ditch delivery system, addressing this challenge would have major planning and fiscal implications to the District in the future. Currently, the overall District's system conveyance losses are estimated to be 15 percent of the total demand, which equates to a loss of approximately 25,000 acre-feet per year.

6.5 WATER MANAGEMENT RECOMMENDATIONS

One of the key factors in assessing the impacts of climate change is the analysis of historical data. The District is well set up for this task as they have developed, and are continuing to develop, data on its system through a network of gages and collection of reservoir data. The collection and analysis of this data should be continually updated and trended to determine and assess changes in the system. The RWMP model has a graphing feature which will aid the District in examining the flow data for each gage over time, and will provide an analytical tool for assessing trends. Frequent data collection will also assist in identifying potential gaging errors as soon as possible to minimize gaps in data collection.

Further, the GIS capabilities utilized by the District can provide insight into growth patterns and a more refined analysis of land use and customer needs. The District is encouraged to incorporate this resource to a greater extent in its future planning efforts. The updated model developed for this Phase of the RWMP is based on a GIS platform, which considers land use patterns and changes, as well as trends in crops and customer uses.

In addition to monitoring and trending data within the District, the following management actions should be considered:

1. Conservation—Develop and implement conservation measures. Conservation measures or demand side management should apply to both treated and agricultural water customers. The District should encourage and provide incentives for reducing water use by promoting water conservation with all customers. Actions to encourage may include the efficient use of treated water, water efficient landscaping, irrigation scheduling and implementing high efficiency irrigation systems. The current practice of letting water run (i.e., no valve) even during wet periods should also be discontinued. In other words, a customer with a 0.5 miner inch service should not allow water to flow at the noted rate from start to the end of irrigation season. Rather water should be utilized when needed. This reduction in the "shoulder" periods of the irrigation season can greatly reduce water usage.

2. System losses—Overall system loss is estimated to be approximately 15 percent of the delivery volume. However, some canals have substantially higher loss values, such as open and/or unlined canals. It is a recommendation within the California Water Plan Update 2009 that open-ditch delivery systems be phase out. While trying to phase out all of the District's open-ditch canals is unfeasible, those canals with higher loss rates, maintenance issues and potential water quality exposure should be reviewed for containment and a potential improvement schedule developed. Options for reducing

system losses in open and/or unlined canals include installing impervious linings in the canals or piping the flows. Detailed canal improvements and recommendations are discussed in detail in Section 8.

3. Canal capacities—The conveyance system infrastructure, specifically the capacity of the canals and other conveyance structures such as intakes, siphons, and culverts, has been assessed for peak flows through 2032. In order to account for potential variations in the future demand calculation, a design value equal to the computed 2032 peak flow, plus 25 percent, has been used as the initial design flow. It is recommended that this design flow be considered on a case by case basis as some canals are nearing buildout and the 25 percent increase may be too large, while others should be sized for even larger flows.

4. Discretionary releases—Reduce or eliminate discretionary releases. Such reductions will, however, have economic consequences that require careful evaluation.

5. Delivery efficiencies—Increase efficiency and encourage water conservation through changes to irrigation water application methods, as outlined in the California Water Plan Update 2009. Metering and/or changes to the water rate structure will encourage conservation, which the District has incorporated to encourage conservation by customers. Research has documented that water rates based on usage are the most effective means for demand side water conservation. This method is also addressed in the District's UWMP, and will be a required element in the District's 2012 agricultural water management plan.

6. Reservoir storage—Investigate the potential to increase water storage. Examine factors impacting reservoir storage such as sedimentation. Due to their proximity to historical hydraulic mining activities, the five largest reservoirs should be evaluated for sediment accumulation, which result in a loss of storage volume. Current bathymetric data, using GIS methodologies, can be readily compared to historical surveys to determine the storage volume lost, the rate of loss, and the location of sediment deposits. BMPs can then be targeted to specific areas to control erosion into the streams and reservoirs. Also, evaluate the use and efficiency of sediment traps on influent streams in order to most effectively manage sediment accumulation. This recommendation will become increasingly important as the impacts of climate change emphasizes the need for storage capacity to accommodate changes in the type, timing and intensity of precipitation.

7. Sedimentation–Increased runoff from rain events in the watershed can increase sediment transport within the system, particularly in the upper division reservoirs. As a result, reduction in storage volume will become an increasing concern. With regular monitoring, the rate of sediment accumulation can be determined and appropriate action planned.

8. Contract water—Investigate the potential for additional water transfers and purchase contracts as supplemental sources of supply. While PG&E purchase options won't be finalized until the FERC relicensing process for the Yuba-Bear and Drum-Spaulding Projects has been completed in 2013, for the purpose of this study, it is assumed that NID will retain the existing purchase options as negotiated with PG&E in the 1963 contract.

9. Watershed supply reliability—Conduct a comprehensive hydrologic analysis of the watershed and reservoir system, including the development of a long-term historical model of the integrated operations of NID and PG&E's Yuba and Bear River systems. It is assumed that this model, at least in framework, has been completed as part of the Yuba-Bear FERC relicensing effort. The model's focus however, should be redirected to examine the impact of the shift from snowmelt to rain, in regards to total yield, and changes resulting from various reservoir rule/operation curves and increases in demand. The analysis could also address issues associated with the sustainable yield of the reservoir system, change in timing of runoff, operations criteria, and drought contingency planning.

10. Drought management—Continuously re-evaluate NID's tools for managing water resources during periods of drought, particularly as demand increases over time, and supply availability is modified as a result of project relicensing and other water rights decisions. Depending on the severity and duration of future droughts, NID appears to have sufficient tools available to manage demand in response to the supply shortages in the short-term. With the projection for increased duration of drought periods, carryover storage becomes increasingly important. Drought contingency measures should become more proactive and based on annual runoff rather than total supply. Voluntary conservation should become status-quo rather than Step 1 in the contingency plan. It is also recommended that the minimum carryover storage value be assessed and increased in both the time of measurement and volume. For example, current minimum carryover storage is determined based on month-end content in October. A second target for minimum carryover storage in December or January 1 may want to be established, if that has not already occurred. This will become increasing more useful as the transition in type of precipitation from snow to rain occurs.

11. Land management—Continue working with local municipalities, county, state, and federal authorities to coordinate and/or develop and implement BMPs for land use development and practices within the watershed. BMPs should be designed to address erosion, runoff, and water quality for a project's future conditions. It is recommended that the District require increased design standards for stormwater management, which would include standards for sedimentation and water quality. For example, if the current requirement is the 6-hour, 10-year storm, it may want to increase the standard to the 6–hour, 20-year storm. These considerations will allow for the capture of runoff for raw water or ground water recharge. As these sources of water become increasingly more important, improving the means to both capture runoff and improve the resulting water quality will become important considerations for the District.

6.6 CONCLUSIONS

Analysis of the District's water rights and the typical supply available concludes that, currently, there is ample supply to meet all District demands now and within the planning horizon of this document. Existing demand was determined to be approximately 163,000 acre-feet. Typically, the available supply is approximately 360,000 acre-feet (Table 5-3). Demand projections detailed in Section 4.0 estimate a future demand (2032) of approximately 205,000 acre-feet (Table 4-6).

Future supply and demand must now consider the impacts of climate change and global warming. It is a well-documented fact that the average annual temperature in California is rising. Already, over the last century the average temperature has increased approximately 1.5 degrees Celsius. Research has determined that the impact of this seemingly small increase in temperature has reduced the snowpack in the Sierra Nevada's by approximately 10 percent. Forecasts estimate that the temperature by mid-century will increase by as much as 5 degrees Celsius, further reducing the snowpack by as much as 40 percent. Additionally, as the snow line moves higher and higher in elevation, precipitation will fall mostly as rain, thereby substantially reducing the natural storage system of the snow pack that has been utilized by the District. Further, the rain events are forecast to become increasingly intense, leading to more runoff and the potential for more frequent and severe flooding. Because the District currently relies on snowmelt and reservoir storage to meet the summer water demands, these factors make reservoir management increasingly important in meeting future demands.

It is also well-documented in the climate change studies that the variation between wet years and dry years will become greater, resulting in greater flood potential and longer and more intense drought periods. Consequently, implementation of drought contingency measures will be more frequent and of longer duration. Conservation and water efficiency measures will become the status-quo rather than an initial drought contingency measure. The regulatory framework for this trend has already started with the implementation of the recently enacted 20 percent by 2020 legislation (SBx7 7).

The District already has many of the tools needed to help them achieve its goal of sustainability. The first is the database maintained by the District regarding flows and reservoir levels (i.e., gages, reservoir data collections, etc.). This database can be analyzed for trends and will provide insights into water supply and demand within the District. The District can also use their existing GIS database system for analytical purposes, examining customer growth and land use patterns.

Demand-side conservation measures can also be achieved through reductions in canal delivery losses and adjustments to carryover storage allocations. Delivery losses can be achieved by reducing canal seepage losses through lining or converting the open ditch systems to either lined canals or conduit. While putting all of the District's canal network in pipe is in the short-term fiscally unrealistic, examination of canals with high loss rates and/or canals of major significance should be prioritized and considered for putting into conduits as part of the District's long-term plan. Not only will this reduce system losses, but it will also protect raw water from increased degradation in water quality. Future intense storm events will result in increased runoff which will carry sediment and other contaminants into the ditch system, resulting in the need for increased maintenance and potentially increased treatment costs.

Carryover storage is a value that should be regularly re-evaluated. Drought conditions are assessed at the beginning of each irrigation season (April) based on total water supply. However, it is recommended that the District continually evaluate conditions throughout the year, and based on reservoir drawdown curves. Further, refill in the fall should meet established refill targets each month to ensure reservoirs begin the irrigation season as close to full as possible in the spring. While this is a difficult task based on snow pack and snowmelt measurements and predictions, it will become increasing more important as annual precipitation transitions to less snow and more rainfall.

Currently, the District can accommodate a single year of drought with minimal impacts to customers or operations. However, in a multi-year event, carryover storage becomes a key component in water supply in the following years of a drought. It is recommended that the District evaluate increasing the carryover storage volume or evaluating carryover volume throughout the winter refill period. As a hypothetical scenario, drawdown could occur to the current minimum carryover level (78,000 acre-feet) in October and then steps initiated to increase carryover volume to 100,000 acre-feet by January 1.

Climate change has introduced a greater level of uncertainty in water management, making management and capital cost decisions difficult. Responding to climate change will require constant vigilance and flexibility. Management practices based on historical data and trends will no longer be applicable and will need to be changed as necessary to meet future conditions. One of the basic tools for water managers in the future will be continued analysis of basic data: stream flow, snow pack, precipitation, reservoir levels, and water use. The District is well-positioned in this area. Future water management will take these data sources and move to real-time management. The basic data noted is also essential input to any predictive model and/or sensitivity analysis used for future planning. It will be imperative for future water management efforts to focus on adaptive management strategies. Sustainable management of water resources is critical to the integrated management of water supply, wastewater, stormwater, river flow, environmental needs and land use.

6.0 WATER MANAGEMENT

The District manages a complicated water storage system that extends from the crest of the Sierra Nevada mountain range to the Central Valley. The primary sources of water consist of snowmelt which is captured and stored in a series of reservoirs. As demand within the District increases, events such as drought and climate change will create new and ever-increasing challenges as the District strives to maintain a sustainable system into the future.

6.1 WATER SUPPLY

The District's water system is a network of ten major reservoirs, 425 miles of canal, and 300 miles of pipeline, as described in Section 3.0. The District's Yuba-Bear system is operated in conjunction with PG&E's Drum-Spaulding system, which are currently undergoing a joint relicensing process through FERC. NID and PG&E established a water management committee (Committee) that meets regularly to coordinate reservoir and canal system operations. The Committee established the following four major operational objectives:

1. Operate NID's system in conjunction with PG&E's Drum-Spaulding system to maximize the use of water for power generation and consumptive use, and minimize spillage.
2. Consumptive needs and regulatory requirements are given the highest priority; power generation and recreation are given a lower priority.
3. Operate to maximize reasonable and beneficial uses within NID's water rights.
4. Fulfill all requirements of contracts/agreements (PG&E, PCWA, CDFG, SWRCB, FERC, customers, special agreements, etc.).

Following these objectives, the Committee coordinates reservoir operations and canal flows of the Yuba-Bear Project with the Drum-Spaulding Project. Flow rates are determined by assessing projected consumptive need, contractual obligations, and current hydrological conditions. The Committee's goal is to fill all reservoirs during the runoff period, have zero spill, and end the year with adequate carryover storage to prevent shortages the following year.

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Through the use of these tools and data sources, the Committee makes decisions on how to operate the system to maximize the project's benefits while keeping a watchful eye on retaining sufficient water in storage to meet anticipated consumptive uses during the rest of the year and for the following year. Week to week decisions are predicated on current watershed conditions and the results of the updated PG&E annual operations model. Since enacting the current operating criteria in 1991, NID has not had to curtail deliveries to its raw and treated water customers.

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[7] In remote areas of the western United States, SNOTEL (snow telemetry) sites, typically comprising a snow pillow, a shielded standpipe storage precipitation gauge, and a radio transmitter, are used to telemeter precipitation data to a satellite.

6.3 DROUGHT CONTINGENCY PLAN

In December 1992, NID adopted a drought contingency plan identifying five stages of water supply shortages and actions to be taken that would enable NID to meet its operational objectives under each stage of drought. The plan was updated in June 2007 to clarify drought planning steps and include additional drought contingencies at various stages of drought. Table 6-1 shows the five stages based upon the April 1st forecast and the demand reduction goal associated with each stage.

As discussed in Section 5.5, the District has sufficient water reserves to handle a single year drought with essentially no reduction in deliveries. However, in keeping with the concerns surrounding the effects of climate change, it is likely that future dry periods could extend over several years at a time. As such, it is suggested that the District initiate drought contingencies based on projected annual runoff instead of the current practice of seasonal snowpack assessment. While the snow melt is a key component of the water supply, analysis of the snowpack only provides a qualitative indication as to the potential supply. Annual runoff figures would include rain events and other sources of supply providing a more complete assessment of the hydrologic condition (i.e., drought).

It is clear that maintaining the minimum carryover storage volume is a key factor in minimizing impact on deliveries during extended dry periods. As a result of the Phase I effort, the District increased the minimum value for carryover storage to 78,000 acre-feet. In light of the data collection, demand projections, recent climate change reports, and analyses undertaken for Phase II of the RWMP, it is recommended that increasing the minimum value for carryover storage be examined once again. Further, conservation should be part of daily/normal operations moving into the future as it will be a key component of achieving a sustainable supply.

Table 6-1 summarizes the current drought contingency plan triggers and the anticipated operative actions. It is recommended that these be reviewed on a regular basis (every five years) to determine if the levels and actions remain appropriate, in particular regards to the minimum volume of carryover storage.

TABLE 6-1. WATER RATIONING STAGES AND REDUCTION GOALS

Stage	April 1st Available Supply (acre-feet)	Supply Shortage (percent)	Type of Rationing Program	Demand Reduction Goals (percent)
I	233,000	None	Normal Operation	0
II (Alert)	210,000	10-15	Voluntary	15
III (Warning)	198,000	15-25	Mandatory	25
IV (Emergency)	175,000	25-35	Mandatory	35
V (Critical)	152,000	35-50	Mandatory	50

Stage I: Normal Water Conditions

1. District will make full supply and contract deliveries.
2. Continue to operate and maintain the water system in an efficient and economical manner.
3. Continue to advise District customers of water conditions and District conservation measures.
4. Routinely evaluate and update water conservation and system storage plans.

Stage II: Drought Alert — 10 to 15 Percent Shortage

1. District leak repair receives high priority.
2. Strongly encourage customers to conserve water.
3. Restaurant owners requested not to serve water unless requested by customers.
4. Declare that no District surplus water is available.
5. Maintain 25 percent of historical end of month October storage for carryover.
6. Limit fire department practice drills and flow testing of fire hydrants.
7. Institute additional agricultural efficiency practices to assist the agriculturalist in proper water management as outlined in the Agricultural Water Management Plan.
8. Limit residential, garden, and landscape irrigation during the hottest portion of the day (10:00 a.m. to 6:00 p.m.).

Stage III: Drought Warning – 25 Percent Shortage

1. All of Stage II requirements above, except item 5, and the following:
2. Reduce untreated water deliveries by 25 percent and impose irrigation season delivery alternatives.
3. Encourage all treated water-metered school grounds and all other public grounds to reduce water usage by 15 percent from what they received under Stage I conditions, as outlined in the District's Urban Water Management Plan.
4. Implement strong conservation pricing on treated water.
5. Prohibit new treated water services from planting new plant lawns, landscaping, or gardens. Encourage customers to use efficient irrigation systems.
6. Maintain at least 78,000 minimum acre-feet in storage at the end of October.

Stage IV: Drought Emergency – 35 Percent Shortage

1. Implement all items under Stages II and III, and the following:
2. Reduce untreated water deliveries by 35 percent and impose irrigation season delivery alternatives.
3. Suspend all new untreated water sales.

Stage V: Critical Drought Emergency – 50 Percent Shortage

1. Implement all items under Stages II, III, and IV, and the following:
2. Reduce untreated water deliveries by 50 percent and impose irrigation season delivery alternatives.
3. Establish conservation oriented rate structures and pricing methods to encourage water conservation.

6.4 CLIMATE CHANGE AND SYSTEM SUSTAINABILITY

Climate change and sustainability are two critical topics requiring attention by District managers for successful water management into the future. There is a substantial body of literature on models and projections of the impact/effect of climate change on water resources. California has been a leader in the area of climate change, sponsoring numerous studies regarding the potential future impacts of climate change.

While there are many varied opinions in regards to timing, most of the studies reviewed agree on several points: The State of California Climatologist, in a report dated 2009 (DWR, 2009g), has noted:

- The mean annual temperature will increase from 2 to 6 degrees C. It is noted however, that the terrain will result in local variations. The points of consensus are that the temperature will rise by up to approximately 5 degrees (F) by 2050
- There will be a decrease in the snow pack in the Sierra Nevada Mountains as a result of the temperature increase.
- Precipitation events will be more intense, resulting in the potential for higher flood peaks.
- The increased intensity will result in greater variation in flows—higher spring flows and lower summer flows.
- Extended drought periods will occur more frequently.

All studies emphasize the importance for immediate response from regulatory and water service agencies to begin planning and take action for future conditions.

6.4.1 CLIMATE CHANGE

A review of the pertinent available literature in regards to climate change and its resulting impact was done with particular attention to California and the Sierra Nevada's. As mentioned above, the California DWR has been a leader in climate change research and the impact of climate change on the California water supply (Figure 6-1). DWR has commissioned or been part of numerous studies which have culminated in the data and recommendations presented in the climate change section of the California Water Plan, Update 2009. It is noted however, that the bulk of the research in regards to climate change has been focused on water supply and ecological restoration. It is recognized that there is a substantial amount of additional research needed in regards to issues such as drought extent and frequency and flood frequency data. Research is ongoing and the models that have been developed and calibrated are being used for more in-depth analyses, which are planned for release in the 2013 Water Plan update.

Research into the aspects of climate change by the DWR has arrived at six basic conclusions, four of which are of interest to NID:

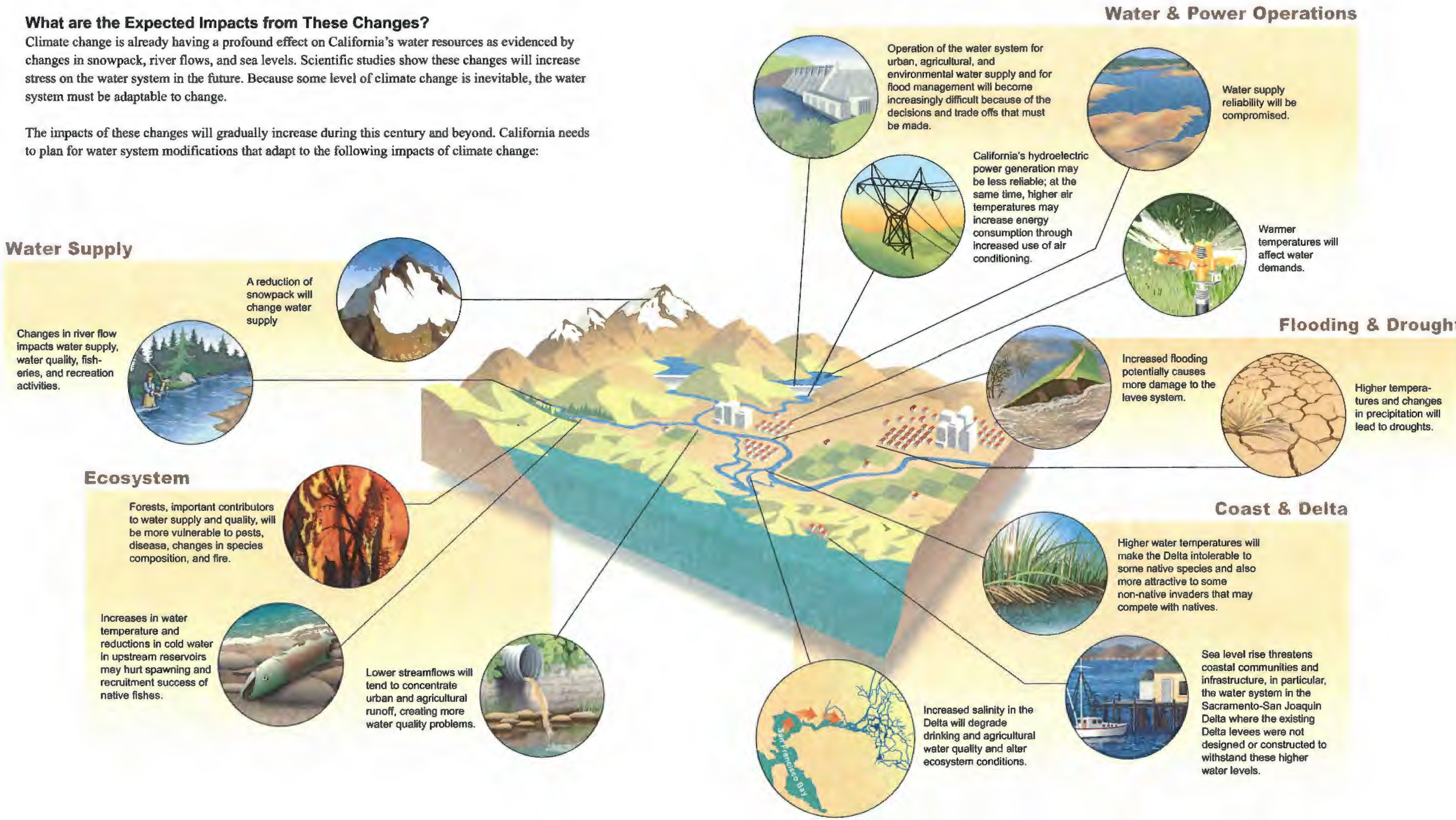
First, it is widely accepted that the average annual temperatures are increasing. As presented in the DWR 2009 update of the California Water Plan, t over the last 100 years the average annual temperature in California has risen approximately 1.5 degrees Fahrenheit (F). It is projected that the mean annual temperature will increase up to 5 degrees F by 2050, although California's widely varied topography will create substantial local variations (DWR, 2010b). The impact of such changes will likely include increased water demand during the irrigation season, resulting not only from warmer temperatures, but also from longer growing seasons, earlier and faster snowmelt in the spring, increased evapotranspiration, and changes to the overall ecosystem (i.e., vegetation changes, forest migration, etc.).

Climate Change: *Stressing Our Water Systems*

What are the Expected Impacts from These Changes?

Climate change is already having a profound effect on California's water resources as evidenced by changes in snowpack, river flows, and sea levels. Scientific studies show these changes will increase stress on the water system in the future. Because some level of climate change is inevitable, the water system must be adaptable to change.

The impacts of these changes will gradually increase during this century and beyond. California needs to plan for water system modifications that adapt to the following impacts of climate change:



As a result of the past century's temperature increase of 1.5 degrees Celsius, the snow pack in the Sierras on average has decreased approximately 10 percent over the last 100 years. Further, climate patterns are becoming more variable. The DWR research has concluded that the average snow pack will decline from between 25 to 40 percent by mid century. Although the total annual precipitation will remain relatively unchanged, the intensity of the wet and dry periods will increase. In the current State Water Plan, the DWR has taken a pro-active position to secure a sustainable water supply for the future and outlined recommendations for strategic goals as well as near- and long-term actions that will assist water managers in sustaining their water resources.

The second conclusion is that while impact to total annual precipitation is uncertain, there will be a noticeable increase in extreme conditions, meaning greater flood events and longer and more intense drought conditions. Storm events are predicted to be more severe, resulting in increased runoff during these events. In the report "Climate Change in Lake Tahoe Basin", 'peak snowmelt in the Upper Truckee River will occur four to six weeks earlier of the century'. This will be a significant factor in the operational planning of reservoir management.

The third conclusion is of particular importance to the District due to its heavy reliance on snow melt for supply and refill of its storage systems. It is predicted that there will be a decreasing snowpack in the northern Sierras. More precipitation is expected to fall as rain in the higher elevations, resulting in more intense runoff events (i.e. shorter duration with higher peak flows). The potential for reservoir spillage, and consequently, water loss, may increase as a result. Future planning should consider the feasibility of increasing existing storage capacities in existing reservoirs or construction of new storages.

The final conclusion is that snowmelt will occur earlier in the season, thereby shifting the timing of the annual runoff. This factor, combined with more rain events than snow, will necessitate a shift in reservoir draw and refill cycles. Further, in order to minimize spillage and ensure the reservoirs are full prior to the beginning of the irrigation season modifications to current operating policies will need to be developed and enacted.

Another literature source reviewed for this analysis was the recent UC Davis study titled "The Effects of Climate Change on Lake Tahoe in the 21st Century: Meteorology, Hydrology, Loading and Lake Response." This study is particularly applicable as the Lake Tahoe watershed is adjacent the District's own watershed. While in general agreement with the assessments made in the California Water Plan, they provide a more specific timeline in regards to the projected watershed changes.

In this report, they note an increase in temperature resulting in a continued shift from snowfall to rain, and earlier snowmelt and runoff during the water year. Currently, 50 to 60 percent of the annual precipitation above 6000 feet falls as snow. Research done as part of this study has predicted this rate to drop to 30 to 40 percent. Further, they have concluded that the duration of the snowpack will be reduced from 248 days to 184 days by the end of the century. Inflows from natural runoff are also predicted to decline with time.

The implications of this shift will increase the frequency and magnitude of flow events. Increased magnitude of flood flow events results in impacts to both flow management and water quality, as the increased flows will pick up more nutrients as well as sediments. As such, storm water runoff and storm water management will become increasingly important considerations in regards to capturing storm runoff, water quality and treatment, and future land management practices. The District will need to review land development practices and work with state, county and local government agencies to implement more stringent land management practices to address future water quality issues.

It is also well-accepted that climate change will impact water demands. The DWR report noted that while climate change appears to have a somewhat lesser impact on future water demand than population growth; it will still be a significant factor in future demand (DWR, 2010b). Further, climate change could potentially offset reductions achieved by implementation of agricultural and urban conservation measures, making such measures that much more important for water resource sustainability.

Including the impacts of climate change is a key consideration in the future operational planning of water resource systems. Traditionally, historical trends and observations have been the basis for water resource planning. At the District, the annual water budget is typically set based on the April snow survey, upon which allocations and deliveries for the year are planned and put into motion. Today, climate change is forcing managers to reevaluate these "tried and true" management strategies. Acceptance that change is occurring and proactive planning for those changes will help the District adapt.

6.4.2 SUSTAINABILITY

Sustainability is defined as the capacity to endure. With respect to the District's water system, sustainability can be defined as the maintenance of supply, or the assurance that there will be sufficient supply in the future. The most widely quoted definition of sustainability is from the Bruntland Commission of the United Nations, which defined sustainability as "...being able to meet the needs of the present without compromising the ability of future generations to meet their needs."

The most immediate and readily apparent action the District can take to promote a sustainable water supply is to establish conservation measures for itself and for its customers to reduce the volume of water use. Other sustainability measures include developing policies and regulations to guide land use practices within the contributing watershed. Land use practices impact supply, water quality, and sedimentation.

The District has implemented a variety of conservation measures and established policies that will assist the District in meeting sustainability goals. Plans and programs initiated by the District include its development of a Strategic Plan and Capital Improvement Plan which focus on conservation, education, and land use practices. These plans are constantly evolving based on conditions within the District. One of the challenges noted in California's Water Plan Update 2009 for the Mountain Counties region, in which the District lies, is to address conservation concerns regarding open ditch delivery systems. Such systems typically have high loss rates and high annual maintenance costs. Further, the open systems are subject to water quality issues such as degradation from local area runoff and potential spills of toxic materials such as oil, gasoline, and pesticides. As a majority of the District's raw water system utilizes an open ditch delivery system, addressing this challenge would have major planning and fiscal implications to the District in the future. Currently, the overall District's system conveyance losses are estimated to be 15 percent of the total demand, which equates to a loss of approximately 25,000 acre-feet per year.

6.5 WATER MANAGEMENT RECOMMENDATIONS

One of the key factors in assessing the impacts of climate change is the analysis of historical data. The District is well set up for this task as they have developed, and are continuing to develop, data on its system through a network of gages and collection of reservoir data. The collection and analysis of this data should be continually updated and trended to determine and assess changes in the system. The RWMP model has a graphing feature which will aid the District in examining the flow data for each gage over time, and will provide an analytical tool for assessing trends. Frequent data collection will also assist in identifying potential gaging errors as soon as possible to minimize gaps in data collection.

Further, the GIS capabilities utilized by the District can provide insight into growth patterns and a more refined analysis of land use and customer needs. The District is encouraged to incorporate this resource to a greater extent in its future planning efforts. The updated model developed for this Phase of the RWMP is based on a GIS platform, which considers land use patterns and changes, as well as trends in crops and customer uses.

In addition to monitoring and trending data within the District, the following management actions should be considered:

1. Conservation—Develop and implement conservation measures. Conservation measures or demand side management should apply to both treated and agricultural water customers. The District should encourage and provide incentives for reducing water use by promoting water conservation with all customers. Actions to encourage may include the efficient use of treated water, water efficient landscaping, irrigation scheduling and implementing high efficiency irrigation systems. The current practice of letting water run (i.e., no valve) even during wet periods should also be discontinued. In other words, a customer with a 0.5 miner inch service should not allow water to flow at the noted rate from start to the end of irrigation season. Rather water should be utilized when needed. This reduction in the "shoulder" periods of the irrigation season can greatly reduce water usage.

2. System losses—Overall system loss is estimated to be approximately 15 percent of the delivery volume. However, some canals have substantially higher loss values, such as open and/or unlined canals. It is a recommendation within the California Water Plan Update 2009 that open-ditch delivery systems be phase out. While trying to phase out all of the District's open-ditch canals is unfeasible, those canals with higher loss rates, maintenance issues and potential water quality exposure should be reviewed for containment and a potential improvement schedule developed. Options for reducing

system losses in open and/or unlined canals include installing impervious linings in the canals or piping the flows. Detailed canal improvements and recommendations are discussed in detail in Section 8.

3. Canal capacities—The conveyance system infrastructure, specifically the capacity of the canals and other conveyance structures such as intakes, siphons, and culverts, has been assessed for peak flows through 2032. In order to account for potential variations in the future demand calculation, a design value equal to the computed 2032 peak flow, plus 25 percent, has been used as the initial design flow. It is recommended that this design flow be considered on a case by case basis as some canals are nearing buildout and the 25 percent increase may be too large, while others should be sized for even larger flows.

4. Discretionary releases—Reduce or eliminate discretionary releases. Such reductions will, however, have economic consequences that require careful evaluation.

5. Delivery efficiencies—Increase efficiency and encourage water conservation through changes to irrigation water application methods, as outlined in the California Water Plan Update 2009. Metering and/or changes to the water rate structure will encourage conservation, which the District has incorporated to encourage conservation by customers. Research has documented that water rates based on usage are the most effective means for demand side water conservation. This method is also addressed in the District's UWMP, and will be a required element in the District's 2012 agricultural water management plan.

6. Reservoir storage—Investigate the potential to increase water storage. Examine factors impacting reservoir storage such as sedimentation. Due to their proximity to historical hydraulic mining activities, the five largest reservoirs should be evaluated for sediment accumulation, which result in a loss of storage volume. Current bathymetric data, using GIS methodologies, can be readily compared to historical surveys to determine the storage volume lost, the rate of loss, and the location of sediment deposits. BMPs can then be targeted to specific areas to control erosion into the streams and reservoirs. Also, evaluate the use and efficiency of sediment traps on influent streams in order to most effectively manage sediment accumulation. This recommendation will become increasingly important as the impacts of climate change emphasizes the need for storage capacity to accommodate changes in the type, timing and intensity of precipitation.

7. Sedimentation–Increased runoff from rain events in the watershed can increase sediment transport within the system, particularly in the upper division reservoirs. As a result, reduction in storage volume will become an increasing concern. With regular monitoring, the rate of sediment accumulation can be determined and appropriate action planned.

8. Contract water—Investigate the potential for additional water transfers and purchase contracts as supplemental sources of supply. While PG&E purchase options won't be finalized until the FERC relicensing process for the Yuba-Bear and Drum-Spaulding Projects has been completed in 2013, for the purpose of this study, it is assumed that NID will retain the existing purchase options as negotiated with PG&E in the 1963 contract.

9. Watershed supply reliability—Conduct a comprehensive hydrologic analysis of the watershed and reservoir system, including the development of a long-term historical model of the integrated operations of NID and PG&E's Yuba and Bear River systems. It is assumed that this model, at least in framework, has been completed as part of the Yuba-Bear FERC relicensing effort. The model's focus however, should be redirected to examine the impact of the shift from snowmelt to rain, in regards to total yield, and changes resulting from various reservoir rule/operation curves and increases in demand. The analysis could also address issues associated with the sustainable yield of the reservoir system, change in timing of runoff, operations criteria, and drought contingency planning.

10. Drought management—Continuously re-evaluate NID's tools for managing water resources during periods of drought, particularly as demand increases over time, and supply availability is modified as a result of project relicensing and other water rights decisions. Depending on the severity and duration of future droughts, NID appears to have sufficient tools available to manage demand in response to the supply shortages in the short-term. With the projection for increased duration of drought periods, carryover storage becomes increasingly important. Drought contingency measures should become more proactive and based on annual runoff rather than total supply. Voluntary conservation should become status-quo rather than Step 1 in the contingency plan. It is also recommended that the minimum carryover storage value be assessed and increased in both the time of measurement and volume. For example, current minimum carryover storage is determined based on month-end content in October. A second target for minimum carryover storage in December or January 1 may want to be established, if that has not already occurred. This will become increasing more useful as the transition in type of precipitation from snow to rain occurs.

11. Land management—Continue working with local municipalities, county, state, and federal authorities to coordinate and/or develop and implement BMPs for land use development and practices within the watershed. BMPs should be designed to address erosion, runoff, and water quality for a project's future conditions. It is recommended that the District require increased design standards for stormwater management, which would include standards for sedimentation and water quality. For example, if the current requirement is the 6-hour, 10-year storm, it may want to increase the standard to the 6–hour, 20-year storm. These considerations will allow for the capture of runoff for raw water or ground water recharge. As these sources of water become increasingly more important, improving the means to both capture runoff and improve the resulting water quality will become important considerations for the District.

6.6 CONCLUSIONS

Analysis of the District's water rights and the typical supply available concludes that, currently, there is ample supply to meet all District demands now and within the planning horizon of this document. Existing demand was determined to be approximately 163,000 acre-feet. Typically, the available supply is approximately 360,000 acre-feet (Table 5-3). Demand projections detailed in Section 4.0 estimate a future demand (2032) of approximately 205,000 acre-feet (Table 4-6).

Future supply and demand must now consider the impacts of climate change and global warming. It is a well-documented fact that the average annual temperature in California is rising. Already, over the last century the average temperature has increased approximately 1.5 degrees Celsius. Research has determined that the impact of this seemingly small increase in temperature has reduced the snowpack in the Sierra Nevada's by approximately 10 percent. Forecasts estimate that the temperature by mid-century will increase by as much as 5 degrees Celsius, further reducing the snowpack by as much as 40 percent. Additionally, as the snow line moves higher and higher in elevation, precipitation will fall mostly as rain, thereby substantially reducing the natural storage system of the snow pack that has been utilized by the District. Further, the rain events are forecast to become increasingly intense, leading to more runoff and the potential for more frequent and severe flooding. Because the District currently relies on snowmelt and reservoir storage to meet the summer water demands, these factors make reservoir management increasingly important in meeting future demands.

It is also well-documented in the climate change studies that the variation between wet years and dry years will become greater, resulting in greater flood potential and longer and more intense drought periods. Consequently, implementation of drought contingency measures will be more frequent and of longer duration. Conservation and water efficiency measures will become the status-quo rather than an initial drought contingency measure. The regulatory framework for this trend has already started with the implementation of the recently enacted 20 percent by 2020 legislation (SBx7 7).

The District already has many of the tools needed to help them achieve its goal of sustainability. The first is the database maintained by the District regarding flows and reservoir levels (i.e., gages, reservoir data collections, etc.). This database can be analyzed for trends and will provide insights into water supply and demand within the District. The District can also use their existing GIS database system for analytical purposes, examining customer growth and land use patterns.

Demand-side conservation measures can also be achieved through reductions in canal delivery losses and adjustments to carryover storage allocations. Delivery losses can be achieved by reducing canal seepage losses through lining or converting the open ditch systems to either lined canals or conduit. While putting all of the District's canal network in pipe is in the short-term fiscally unrealistic, examination of canals with high loss rates and/or canals of major significance should be prioritized and considered for putting into conduits as part of the District's long-term plan. Not only will this reduce system losses, but it will also protect raw water from increased degradation in water quality. Future intense storm events will result in increased runoff which will carry sediment and other contaminants into the ditch system, resulting in the need for increased maintenance and potentially increased treatment costs.

Carryover storage is a value that should be regularly re-evaluated. Drought conditions are assessed at the beginning of each irrigation season (April) based on total water supply. However, it is recommended that the District continually evaluate conditions throughout the year, and based on reservoir drawdown curves. Further, refill in the fall should meet established refill targets each month to ensure reservoirs begin the irrigation season as close to full as possible in the spring. While this is a difficult task based on snow pack and snowmelt measurements and predictions, it will become increasing more important as annual precipitation transitions to less snow and more rainfall.

Currently, the District can accommodate a single year of drought with minimal impacts to customers or operations. However, in a multi-year event, carryover storage becomes a key component in water supply in the following years of a drought. It is recommended that the District evaluate increasing the carryover storage volume or evaluating carryover volume throughout the winter refill period. As a hypothetical scenario, drawdown could occur to the current minimum carryover level (78,000 acre-feet) in October and then steps initiated to increase carryover volume to 100,000 acre-feet by January 1.

Climate change has introduced a greater level of uncertainty in water management, making management and capital cost decisions difficult. Responding to climate change will require constant vigilance and flexibility. Management practices based on historical data and trends will no longer be applicable and will need to be changed as necessary to meet future conditions. One of the basic tools for water managers in the future will be continued analysis of basic data: stream flow, snow pack, precipitation, reservoir levels, and water use. The District is well-positioned in this area. Future water management will take these data sources and move to real-time management. The basic data noted is also essential input to any predictive model and/or sensitivity analysis used for future planning. It will be imperative for future water management efforts to focus on adaptive management strategies. Sustainable management of water resources is critical to the integrated management of water supply, wastewater, stormwater, river flow, environmental needs and land use.

7.0 REVIEW OF DISTRICT WATER MANAGEMENT POLICY AND PROCEDURES

7.1 STATE INITIATIVES

The Phase I Raw Water Technical Analysis of the RWMP included a detailed review of the District's water management policies and procedures that were in place at the time (2007). Since Phase I there have been significant changes and updates at the state level. Most notably, the California Water Plan Update 2009, the 20x2020 Water Conservation Act (SBx7 7), and the Agriculture Water Management Plan requirements, all of which were part of a comprehensive water legislation package that was signed into effect at the end of 2009. Additionally, the California Department of Water Resources (DWR) has issued several documents over the past two years addressing climate change and sustainability, which will have significant impacts on future water management within California. These state initiatives are a result of recommendations made in California Water Plan Update 2009 and are in response to the issues surrounding climate change.

7.1.1 CALIFORNIA WATER PLAN UPDATE 2009

The 2009 update to the California Water Plan addresses such issues as drought, flood risk, declining ecosystems, impaired water bodies, climate change and aging infrastructure. While statewide in scope, the State Plan contains sections which are both germane and specific to the District and the Mountain Counties Region in which the District lies. The Plan lists 13 objectives which are intended to facilitate statewide water management for "a changing climate and other uncertainties and risks, and provide a more adaptive and resilient ecosystem and more sustainable water and flood systems." While not all of these objectives are applicable to District operations, objectives such as integrated regional watershed management planning and water conservation are very pertinent to the District's management of its current and future water resources. Contained within the objectives are more than 115 suggested actions for consideration by water managers. In regards to conservation, 14 Best Management Practices (BMPs) are suggested for incorporation by water districts across the state into their respective policies and procedures, as applicable.

7.1.2 20X2020 WATER CONSERVATION ACT

As part of the 2009 comprehensive water package, the State enacted the 20x2020 Water Conservation Act. This plan calls for a 20 percent reduction in urban water use by the year 2020. The Act requires the establishment of a baseline gallons per capita per day (GPCD) usage for urban water suppliers, from which conservation will be measured. Overall, the statewide target is to reduce the current average of 192 GPCD to 154 GPCD by 2020. Recommendations noted in the 2009 update to achieve this goal have the potential to substantially impact current District practices and operations. For example, future grant funding of water programs could be tied directly to performance as a result of this initiative. It is noted in the California Clean Water Safe Revolving Fund (CWSRF) Intended Use Plan that projects that promote conservation, enhance and encourage sustainable activities, and/or are climate-related will receive a higher priority in competition for funding. Other initiatives recommended in this program include potential for mandates in regards to landscape irrigation management practices, revisions to water efficiency code, encouragement or mandate of conservation water pricing and additional enforcement tools. Preparation of the District's 2010 Urban Water Management Plan (UWMP) is currently in progress. The 2010 UWMP is a key component of the 20x2020 Water Conservation Act – it establishes the baseline for the District from which the implementation of conservation measures will be measured and the District's compliance with the Act.

7.1.3 AGRICULTURAL WATER MANAGEMENT PLANNING ACT

Another important piece of legislation passed by the State is the Agricultural Water Management Planning Act, which will require the District to develop and adopt an agricultural water management plan (AWMP) with specified components and implement cost-effective efficient water management practices. The Act recommends the Agricultural Water Management Council's classification of Efficient Water Management Practices (EWMP) for agricultural water conservation measures and practices (California Water Plan Update 2009). These practices are broken down into three primary classifications:

1. Generally Applicable Efficient Water Management Practices (required of all signatory water suppliers)
2. Conditionally Applicable Efficient Water Management Practices – Practices Subject to Net Benefit Analysis and Exemption from Analysis.
3. Practices Subject to Detailed Net Benefit Analysis without Exemption

In addition to the EWMPs listed above, there are important cultural practices such as soil management, cover crops, changes in tillage practices, land management practices, winter storm water capture and use, and dry and rain-fed farming that can reduce applied water and increase water use efficiency. The District's newly hired Water Efficiency Technician shall develop a program to work with agricultural landowners addressing BMPs for water conservation and efficiency.

7.2 District Objectives, Policies and Procedures

The District uses an open ditch system as the primary means of water delivery to the individual water users. Additionally, the District operates and maintains several water treatment plants for the provision of potable water within the District. In addition to the open ditch system, the conveyance network includes numerous structures such as siphons, flumes, and pipes, some of which have been in operation for over 100 years. The open ditches and flumes are prone to excessive seepage loss as well as damage from forest fires, storm events, sedimentation, and debris. Additionally, a significant portion of the District's conveyance infrastructure is now undersized to meet the current and forecast peak flows. Water quality issues such as those resulting from chemical spills, stormwater runoff and contaminated runoff are a constant threat to the District's system and one that has potential to increase with climate change.

The District has updated their Strategic Plan, prioritizing the objectives to address current issues. Many of the strategic items listed in the Strategic Plan are directly related to the findings noted in this RWMP. Expansion of service, protection of water quality through watershed management, developing a strategy to evaluate increased storage, and developing a management system that will maintain, replace, expand existing assets are a few of the key items in the plan. NID has established policies and procedures which address a wide range of water management topics, including but not limited to, daily system operation, canal/conveyance protection, expansion and annexation procedures, and conservation measures. The policies and procedures most pertinent to the raw water master planning relate to canal protection and improvement, and conservation measures. The following sections summarize the current policies and procedures contained in the District's strategic plan.

2009/2010 Number	Objective
1	Proactively expand water services to existing and new customers within service territory.
2	Complete and implement NID's strategic plan and design, develop and implement a process for financial planning in alignment with NID's Strategic Plan.
3	Design, develop, implement, evaluate and improve a management system for maintaining, replacing, expanding, consolidating and protecting existing assets.
4	Define and develop strategy for hydroelectric contracts for the sale of energy.
5	Protect water quality through active watershed management and stewardship.
7	Ensure and maintain reliability and efficiency in our deliver system.
9	Design, develop and implement a strategy to increase storage
11	Actively preserve water rights through active management practices, internally and externally to the District.
13	Design, develop and implement a strategy for resource planning.
15	Implement a strategy for retaining and improving hydroelectric contract relationships for water supply.
23	Evaluate and improve existing systems for regulatory compliance and participate in the development of governing relations.

Source: NID Strategic Plan 2010-2011 Proposed Prioritized Objectives.
http://www.nid.dst.ca.us/strategic.cfm

7.2.1 District Policies

Review of the District's previous RWMP reported three policies that address improvements within the canal conveyance system.

7.2.1.1 Policy for Small Lateral Improvements and Development

This policy addresses the improvements of small lateral facilities in respect to other facilities within the District. The policy lists the means to establish priority and sizing methods for improvements, time sequence for staged improvements and method for determining when to initiate the improvements. A 25 percent increase to the computed peak flow for 2027 is the current applicable design flow for upgrades and modifications to the canals throughout the District. This increase provides sufficient cushion to cover increases in demand well into the future. It is, however, suggested that this value be modified on a case by case basis as the canal segments reach their respective buildout targets. The recently adopted Strategic Plan (2006) and the Capital Improvement Plan included in this report (Section 8.0) are significant steps forward in implementing this policy.

It is suggested that emphasis continue to be placed on improvements needed to maintain reliable flows to water treatment plants. Data shows that water delivery to the various treatment plants is becoming an increasingly larger component of the overall water demand, and providing infrastructure to meet projected increases in flow to these plants will be a high priority for NID in the future.

7.2.1.2 POLICY FOR WATER CONSERVATION AND URBAN ENCROACHMENT

The District encourages, facilitates, and assists with water conservation efforts throughout its service area. The water conservation measures and practices used by the District are outlined in Section 6.0. Additionally, the District recently completed its 2010 Urban Water Management Plan, which established baseline water demand within the District and recommendations for conservation measures and policies consistent with the practices and methods identified in the California Water Plan Update 2009. The District employs demand side management measures, consisting of a 14-step program primarily targeting land and water use practices of treated water customers (Brown and Caldwell, 2011) (Table 7-1).

7.2.1.3 POLICY FOR RECAPTURE/REUSE OF RETURN FLOWS

This policy encourages the recapture and reuse of return flows within the District. NID is making efficient use of natural inflow and return flows in their operations and has been proactive in these areas. Recapture and use of recycled water is also one of the recommendations in the state's Water Plan Update 2009 and will become increasingly more important in the future. The District is actively using recycled water and looking for opportunities to increase such utilization and recapture water. Currently, the District reports a recycled volume of approximately 3,000 acre-feet.

TABLE 7-1. WATER CONSERVATION DEMAND MANAGEMENT MEASURES – NID 2010 UWMP

DEMAND MANAGEMENT MEASURE NO.	NID MANAGEMENT MEASURES	DISTRICT COMPLIANCE STATUS/RECOMMENDATIONS
DMM1	Water survey program for single-family residential and multi-family residential connections.	Monitor and modify to meet conditions.
DMM2	Residential plumbing retrofit.	Continue to be pro-active as improvements are made.
DMM3	System water audits, leak detection and repair.	Continue program.
DMM4	Metering with commodity rates for all new connections and retrofit of existing conditions.	Fully implemented and continuous.
DMM5	Large landscape conservation programs and incentives.	Continue program. Monitor and adapt to meet changing conditions.
DMM6	High-efficiency washing machine rebate programs.	Evaluate benefits of program at NID.
DMM7	Public information programs.	Continue to provide education resources.
DMM8	School education programs.	Continue programs on regular basis.
DMM9	Conservation programs for commercial, industrial and institutional accounts.	Monitor and continue.
DMM10	Wholesale agency assistance programs.	Continue to work on demand side conservation strategies.
DMM11	Conservation pricing.	Ongoing.
DMM12	Conservation coordinator.	Ongoing.
DMM13	Water waste prohibition.	Ongoing.
DMM14	Residential ultra low flow toilet replacement programs.	Currently not implementing this DMM.

Source: California State Water Plan Update 2009; 2010 NID Urban Water Management Plan.

7.2.2 DISTRICT PROCEDURES

7.2.2.1 DATA COLLECTION AND STREAM GAGING

The District currently operates a network of 164 gages and has an ongoing initiative to place a flow gage at the head of every canal with flows of 5 cfs or more. This is in keeping with the recommendations contained within the state's Water Plan Update 2009. Since the completion of the Phase I report, 18 new gages have been added to, or relocated within, the system. The ability to evaluate the historical record through statistical and trend analyses can provide significant insights as to growth and development of various areas within the District, as well as the changes in the system evolving from climate change. For example, year to year comparison is not a very good indicator of future conditions, but trending data over the past 10 to 15 years or more begins to show a pattern than can be useful for further planning. The demand model developed and updated for this report will provide a dynamic tool that the District can use for statistics and analyses that will facilitate planning efforts (see Section 4.0 for methodology and results of the model). Placement of additional gages, gaging canals with lesser flows, and the continued recording and analysis of the daily flow data is recommended. It is also recommended that the District consider expansion and evaluation of additional parameters within the District including precipitation, temperature and snow pack, and date of end of snowmelt that affect water supply and timing of runoff that are critical for planning District operations. Such data will be imperative for any future modeling of system conditions that will facilitate the District's sustainable management of its water resources.

7.2.2.2 CURRENT NID CONSERVATION PRACTICES

Water conservation is a priority for NID and a water conservation program is being developed. Current conservation practices include free public seminars and workshops, water efficiency publications, and a drought tolerant and irrigation efficient demonstration garden onsite. On the supply side, NID has adopted a drought contingency plan, which is discussed in detail in Section 6.0. In addition to conducting the annual supply determinations, NID is continually seeking ways to improve system efficiency and reduce losses within the delivery system. System efficiency is a preferred conservation method as it is a means by which the District can reduce water loss without impacting customer water use.

Conservation measures are outlined in the State's best management practices (BMPs) for raw and urban water as provided in the California Water Plan Update 2009. As identified in its UWMP, the District has implemented its own demand side management measures through a 14 step conservation program, primarily addressing treated water customers (Table 7-1). As mentioned above, the District has initiated its 2010 Urban Water Management Plan update, in which these conservation measures will be revised as necessary to be consistent with the updated BMPs contained within the State's Water Plan Update 2009. Based on these recommendations, and the newly developed UWMP Guidelines recently released by the DWR, the District will begin the process of moving toward the 20x2020 Water Conservation Plan requirements, including adopting the baseline GPCD. One of the BMPs contained within the current state water plan notes that water conservation specialists have concluded that water pricing measures is one of the most effective methods in reducing urban water use (California Water Plan Update 2009). Towards this measure, NID has already instituted various pricing schedules based on water use.

The District's current Agricultural Water Management Plan (AWMP) was prepared in compliance with Article 2.8 Division 6 of the State Water Code. This plan identifies action items and processes for purposes of agricultural water conservation. While it focuses primarily on supply-side activity, some demand-side measures were also adopted:

1. Use of reclaimed water
2. Development and use of flow gaging stations throughout the District
3. Updated raw water system capital improvement list
4. Use of snow survey data to monitor snow pack and predict runoff
5. Staff training in conservation measures
6. Working with agricultural producers and growers to improve irrigation practices and efficiencies
7. Water loss prevention program
8. Investigate new delivery systems
9. Landscape water management training

As previously noted, the District will be subject to the new regulations requiring preparation and submittal of an updated Agricultural Water Management Plan to DWR by December 31, 2012. With the signing of the 2009 California Water Package, legislation was enacted that tied grant eligibility to preparation and filing of UWMP and AWMPs for qualifying districts and agencies. As mentioned above, projects requesting grant monies will be ranked based on aspects of conservation, improvements to water quality and sustainability of the resource.

7.2.2.3 INTEGRATED REGIONAL WATER MANAGEMENT

In late 2002, DWR began administering an Integrated Regional Water Management (IRWM) grant program for improving water planning and use throughout the State. The intent of developing integrated regional water management plans (IRWMP) was to (1) improve utilization of local water supplies, (2) protect communities from droughts, (3) protect and improve water quality, (4) reduce dependence on imported water, (5) promote integrated regional planning, and (6) and achieve multiple water supply and water quality benefits and objectives.

In 2005, NID joined a multi-faceted planning group consisting of various stakeholders representing interests and watershed responsibility within the region for the development of the Cosumnes, American, Bear, and Yuba Rivers (CABY) Integrated Regional Water Management Plan (IRWMP). The first CABY IRWMP effort was completed in 2007 and has since undergone an update, with a second update planned for the 2010 funding cycle. One of the benefits of joining this regional planning effort was that it provided an avenue to obtain grant funds for a pilot program for mercury extraction in the Bear River.

7.3 RECOMMENDATIONS

Management of water resources is an ever-increasing challenge, particularly in relation to climate change and increased pressures on sustainability statewide. Reduced supply, increased demand and aging infrastructure, combined with climate change, drought, and environmental considerations are significant challenges that will face the District in the years to come. Managing this resource in light of increasing demand and the aspects of climate change, in a sustainable manner that will ensure its ability to meet demands into the future will require both pro-active and adaptive management. As discussed in Section 6.0, climate change has added an increased level of uncertainty to water management. As such, the District will need to be open and pro-active in its development and enactment of policies. In a recent article by Tom Iseman, Program Director for Water Policy and Climate Adaptation, Western Governors Association, it was noted that " climate change adds an additional complexity; strategies rooted in historical data and trends may need to change. In other words, stationarity, or maintaining the status quo, is dead." Further, the performance of one system impacts the performance of many other systems. It is therefore essential that the District regularly review the operations and design of its infrastructure and determine what modifications may be required to adapt to the changing conditions.

7.3.1 Conservation Policies

A major component in achieving a sustainable supply is conservation. The State initiated an aggressive mandate to conserve 20 percent of the urban water supply by the year 2020. This requires that the District enact new policies and/or enhance existing policies to achieve these results. While the District has in place most of the applicable conservation policies, they should be reviewed regularly to ensure that they are up to date and meeting the necessary objectives. Regular review and update of the District's UWMP is already mandated by State regulations and the District is in compliance with these requirements. Additionally, as mentioned above, the State enacted in 2009 a requirement for AWMPs that will also be required to address conservation measures and methods.

7.3.2 Data Collection

Data collection and analysis is a key factor for evaluating system changes and impacts and effects of those variances. As previously noted, the District maintains a flow gage system of approximately 164 gages. Many of these gages have a substantial period of record. Trend analyses of the data can provide confirmation of growth, effectiveness of conservation measures and effects of climate change given sufficient time. It is recommended that the District itself, or in cooperation with other Districts, state and federal agencies, expand their data network to include rainfall, snowfall, temperature data collection at more locations within the District. Other pertinent data should be collected and analyzed as well, including snowfall totals, water content, and end date for annual snowmelt. As the data record is established and extended, it will provide insights into the effects of growth and impacts of climate change on the system. While overall growth showed a gain of approximately 2 percent, the demand analyses showed an estimated annual increase in demand of approximately 1 percent per year. Conservation measures that reduce demand by an equivalent rate would maintain the status quo for many years to come. The demand analysis also showed that the District is currently at 48 percent saturation and is expected to increase to 60 percent by 2032. Installation of data collection gages, and implementation of conservation measures and recommendations, and the Capital Improvement

Program (CIP) (Section 8.0) will facilitate the District in meeting its goals of conservation, sustainability of supply, and provision of quality water to all its customers.

7.3.3 CAPITAL IMPROVEMENTS

Capital improvements will be another major challenge for the District in the future. While water demand within the District continues to increasing, the existing infrastructure in many locations is undersized to handle the projected capacity increases. The District uses an open ditch system as the primary means of water delivery to the individual water users. In addition to the open ditch system, the conveyance network includes numerous structures such as siphons, flumes, and pipes, many of which have been in operation for over 100 years. The open ditch system is especially prone to excessive seepage loss, damage from forest fires, storm events and sedimentation and debris and issues with water quality resulting from storm water runoff and other means of contamination.

As the District undertakes these capital improvements, design plans should incorporate supply side conservation measures to reduce system losses to the greatest extent possible. This will continue to be a significant challenge for the District going forward, both in terms of meeting the conservation requirements (i.e., minimizing seepage and evapotranspiration) and reducing potential issues such as impacts on water quality and interruptions in service due to canal failures.

7.3.4 LAND USE REGULATIONS

The District is encouraged to continue working with state, county and local agencies to develop and implement land use regulations (BMPs) that will serve to enhance both water supply and water quality. For example, stormwater runoff impacts water quality, supply and recreation, and is often a direct result of land use planning and development activities. By working together, the District can become an active participant in land use decisions and regulations that will help protect and sustain its water resources.

7.3.5 SUMMARY OF RECOMMENDATIONS

Overall, looking forward, the District's policies and regulations will need to remain flexible and regularly updated as required to meet the changing future conditions. The following recommendations are broad in scope and have conservation and response to climate change as the primary impetus.

Conservation Policies	• Regularly review District conservation policies for consistency and compliance with State updates. • Seek participation and testing of new agricultural water conservation practices, such as alternate day irrigation or irrigation based on soil moisture data. • Investigate means and prioritize canal locations where losses are known to be significant to reduce delivery losses
Data Collection	• Continue data collection and monitoring. System should be expanded to meet future need by installing additional data collection gages • Implement land use conservation measures and recommendations contained in the RWMP, UWMP, and future AWMP • Implement the recommendations in the CIP (Section 8.0)
Capital Improvements	• Implement the CIP (Section 8.0). Look to incorporate conservation measures and adaptability in design.
Land Use Regulations	• Continue to work with local land use agencies regarding land use regulations, BMPs, and stormwater management.

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APPENDIX A

SERVICE AREA SOFT BOUNDARY CHANGES

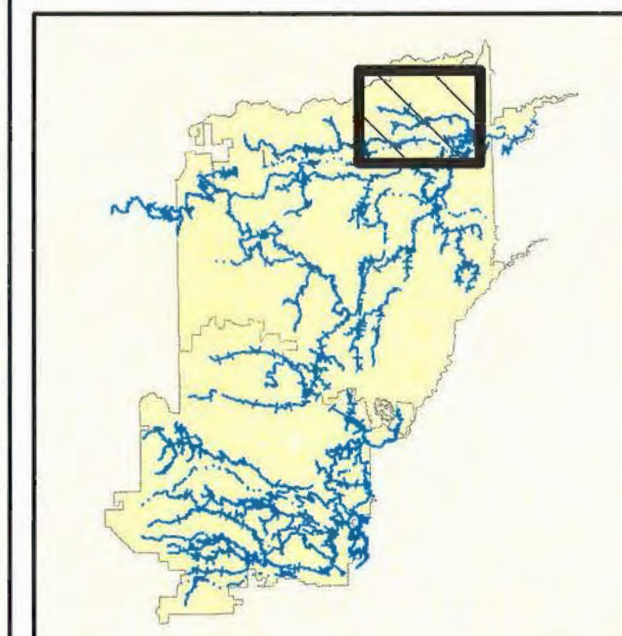
SNOW MOUNTAIN SERVICE AREA CHANGES FROM PHASE 1

Figure A-1

Canal
Random/Creek
Siphon/Pipe
Tunnel
No Change to Service Areas
Phase 1 Service Area Boundaries
Phase 2 Service Area Boundaries

0 1,500 3,000 6,000 Feet

Phase 2 Net Service Acreage Change	
Cement Hill 1	-
Cement Hill 2	1.5
Lake Vera Pipe	9.6
Red Hill 1	(3.0)
Red Hill 2	15.5
Red Hill Reservoir & Pipe, Buffington	1.2
Snow Mountain 1	23.9
Snow Mountain 2	3.8
Snow Mountain 3	-
Sugarloaf Reservoir	-
Willow Valley	-



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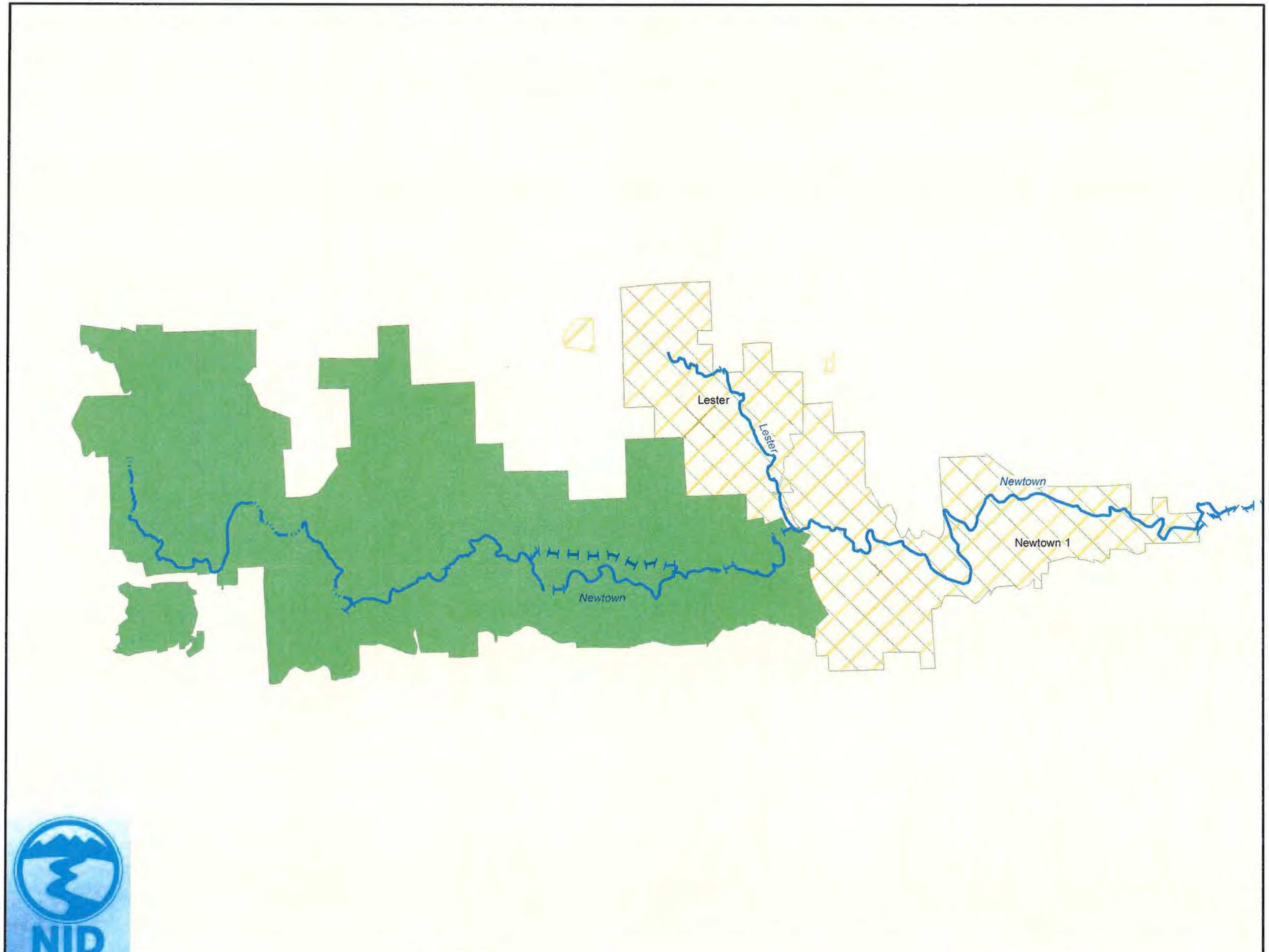
NEWTOWN SERVICE AREA CHANGES FROM PHASE 1

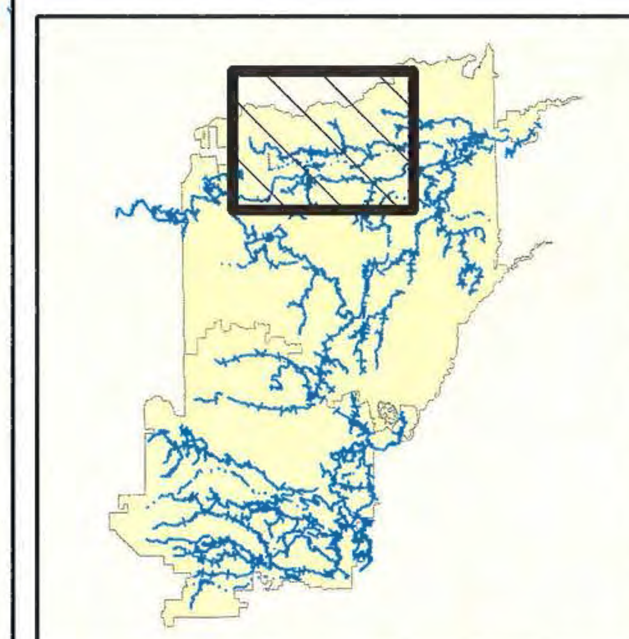
Figure A-2



Canal
Random/Creek
Siphon/Pipe
Tunnel
No Change to Service Areas
Phase 1 Service Area Boundaries
Phase 2 Service Area Boundaries

0 2,250 4,500 9,000 Feet

Phase 2 Net Service Acreage Change	
Lester	36.3
Newtown 1	4.2
Newtown 2	-
Newtown 3	-



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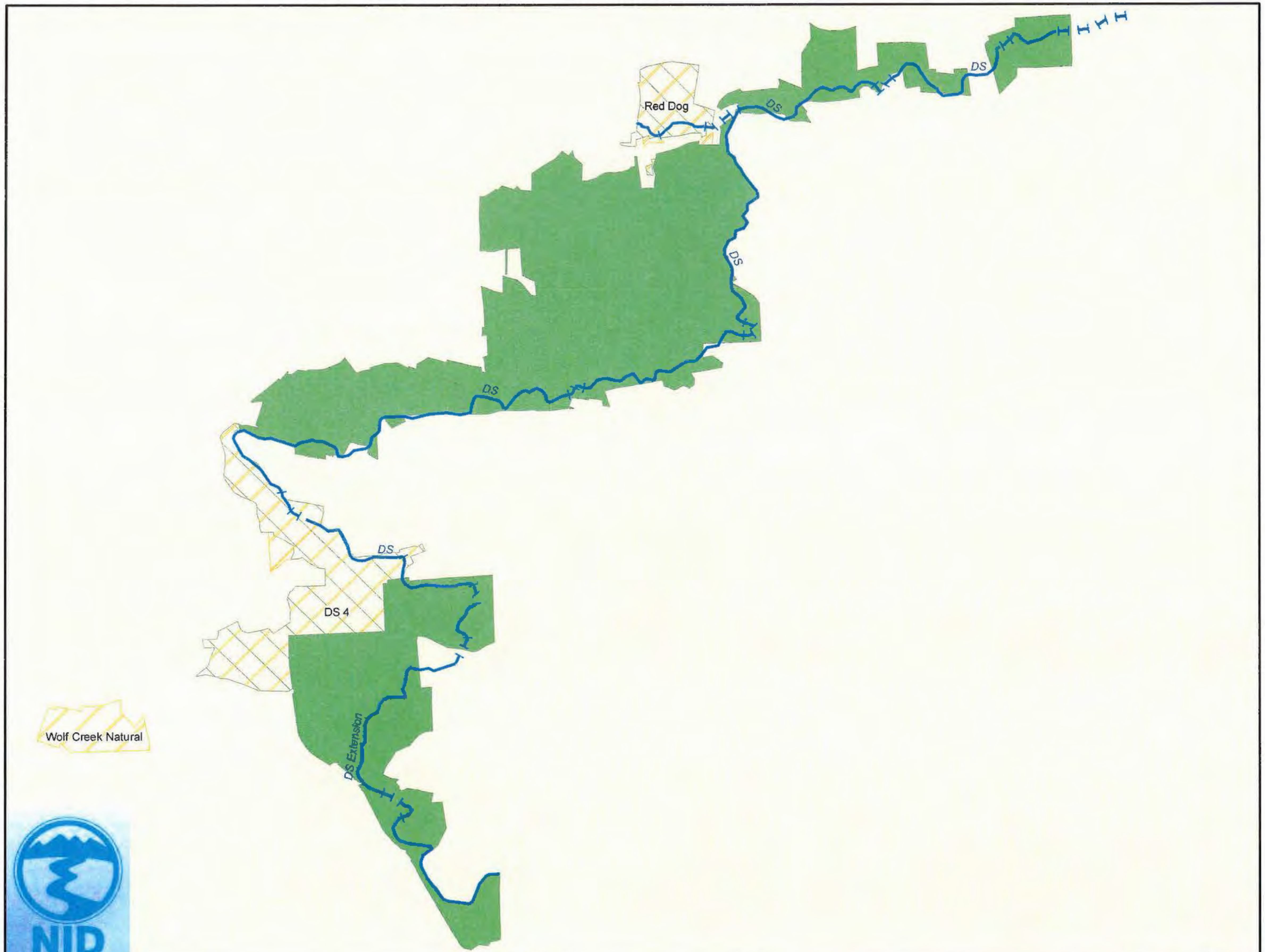
DS SERVICE AREA CHANGES FROM PHASE 1

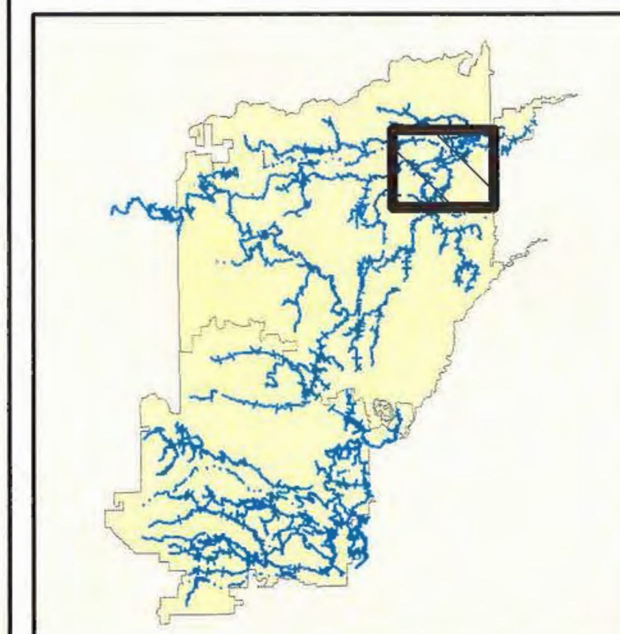
Figure A-3



Canal
Random/Creek
Siphon/Pipe
Tunnel
No Change to Service Areas
Phase 1 Service Area Boundaries
Phase 2 Service Area Boundaries

0 1,250 2,500 5,000 Feet

Phase 2 Net Service Acreage Change	
DS 1	-
DS 2	-
DS 3	-
DS 4	8.5
DS Extension	-
Red Dog	3.1
Wolf Creek Natural	56.9



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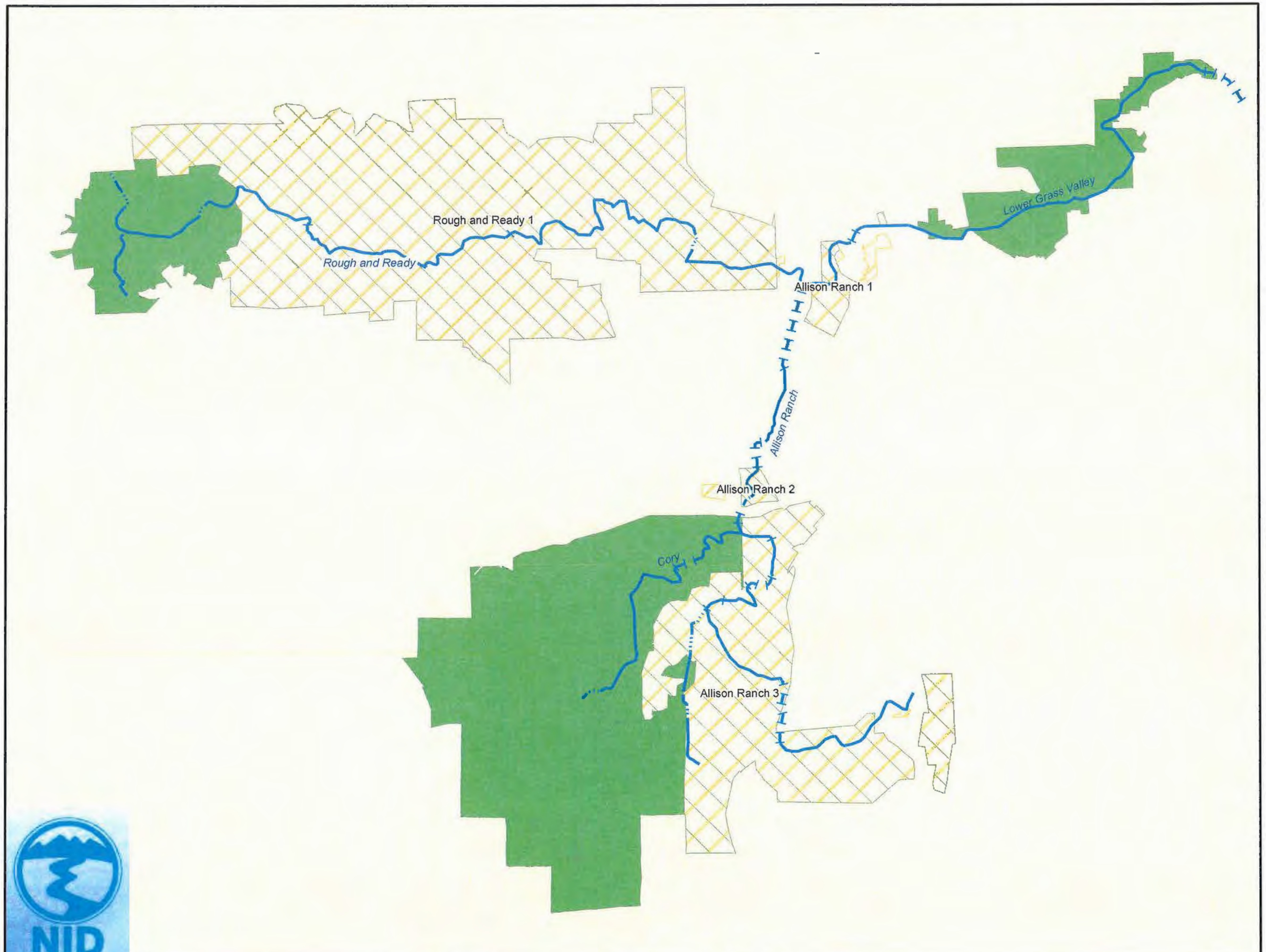
LOWER GRASS VALLEY SERVICE AREA CHANGES FROM PHASE 1

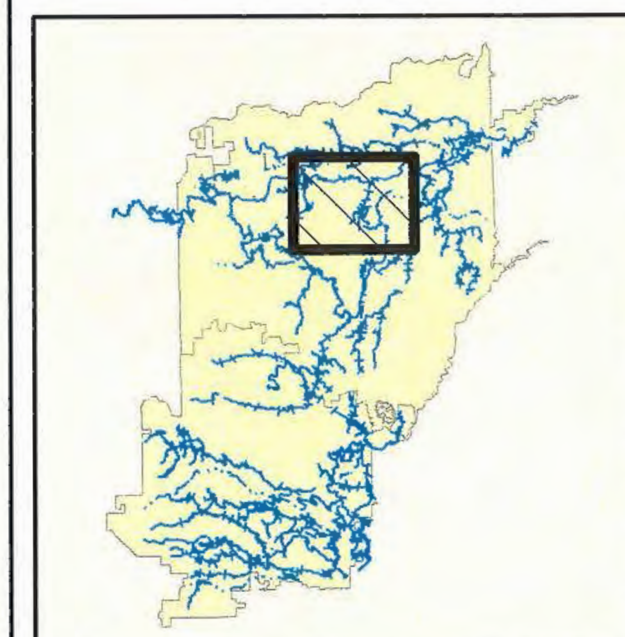
Figure A-4



- Canal
- Random/Creek
- Siphon/Pipe
- Tunnel
- No Change to Service Areas
- Phase 1 Service Area Boundaries
- Phase 2 Service Area Boundaries

0 1,500 3,000 6,000 Feet

Phase 2 Net Service Acreage Change	
Allison Ranch 1	12.9
Allison Ranch 2	6.1
Allison Ranch 3	1.7
Cory	-
Lafayette	-
Lower Grass Valley	-
Rough and Ready 1	1.7
Rough and Ready 2	-



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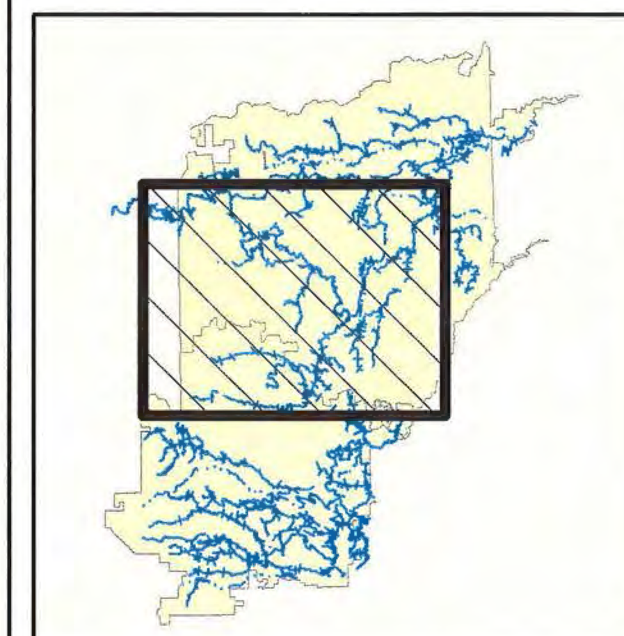
TARR & B SERVICE AREA CHANGES FROM PHASE 1

Figure A-5

Phase 2 Net Service Acreage Change	
B, Miller & Upper Wolf*	-
Bald Hill	-
Beyers	-
Carpenter	-
Casey Loney Canal & Stinson Pipe	0.8
Clear Creek	15.2
Cole	-
Cole Viet**	-
Lower Cole Viet**	-
Lower Wolf	-
Pearl Barnes	-
Pet Hill (1)	-
Pet Hill (2)	-
Pet Hill Extension	4.8
Smith Gordon	14.4
Tarr (1)	11.0
Tarr (2) & Breckenridge	-
Tarr (3)	-
Tarr (4)	-

*Service areas combined. Total equals Phase 1.
**Service areas split. Total equals Phase 1.

For acreage changes table see lower right of map



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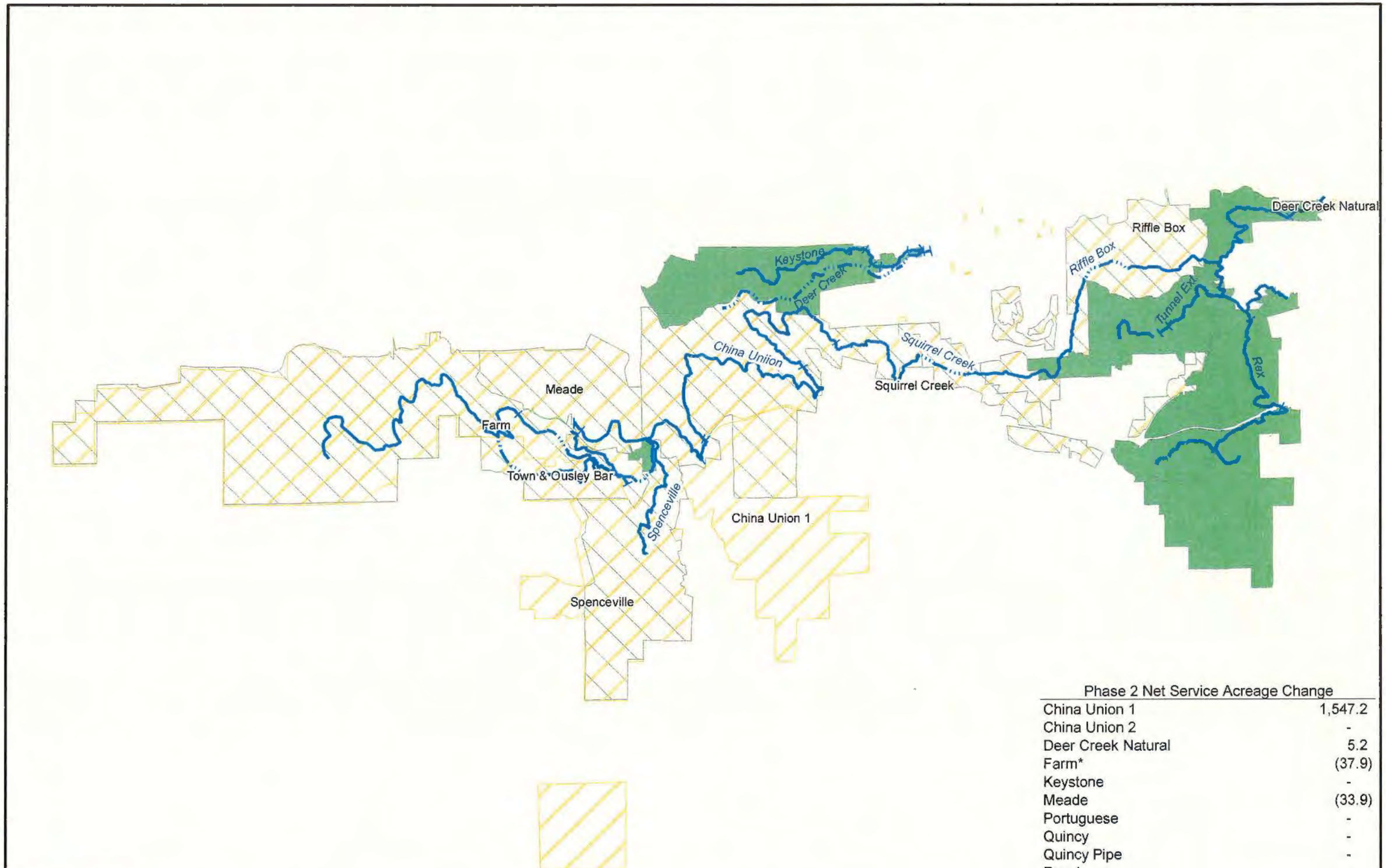
TUNNEL & CHINA UNION SERVICE AREA CHANGES FROM PHASE 1

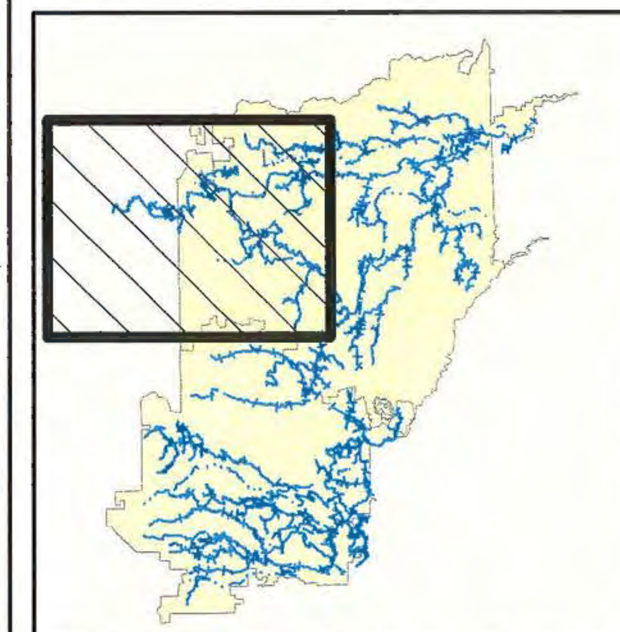
Figure A-6



For acreage changes table see lower right of map

Phase 2 Net Service Acreage Change	
China Union 1	1,547.2
China Union 2	-
Deer Creek Natural	5.2
Farm*	(37.9)
Keystone	-
Meade	(33.9)
Portuguese	-
Quincy	-
Quincy Pipe	-
Rex 1	-
Rex 2	-
Riffle Box	7.4
Spenceville	954.7
Squirrel Creek	4.5
Town & Ousley Bar*	-
Tunnel	-
Tunnel Extension	-

*Service areas were split in addition to being edited



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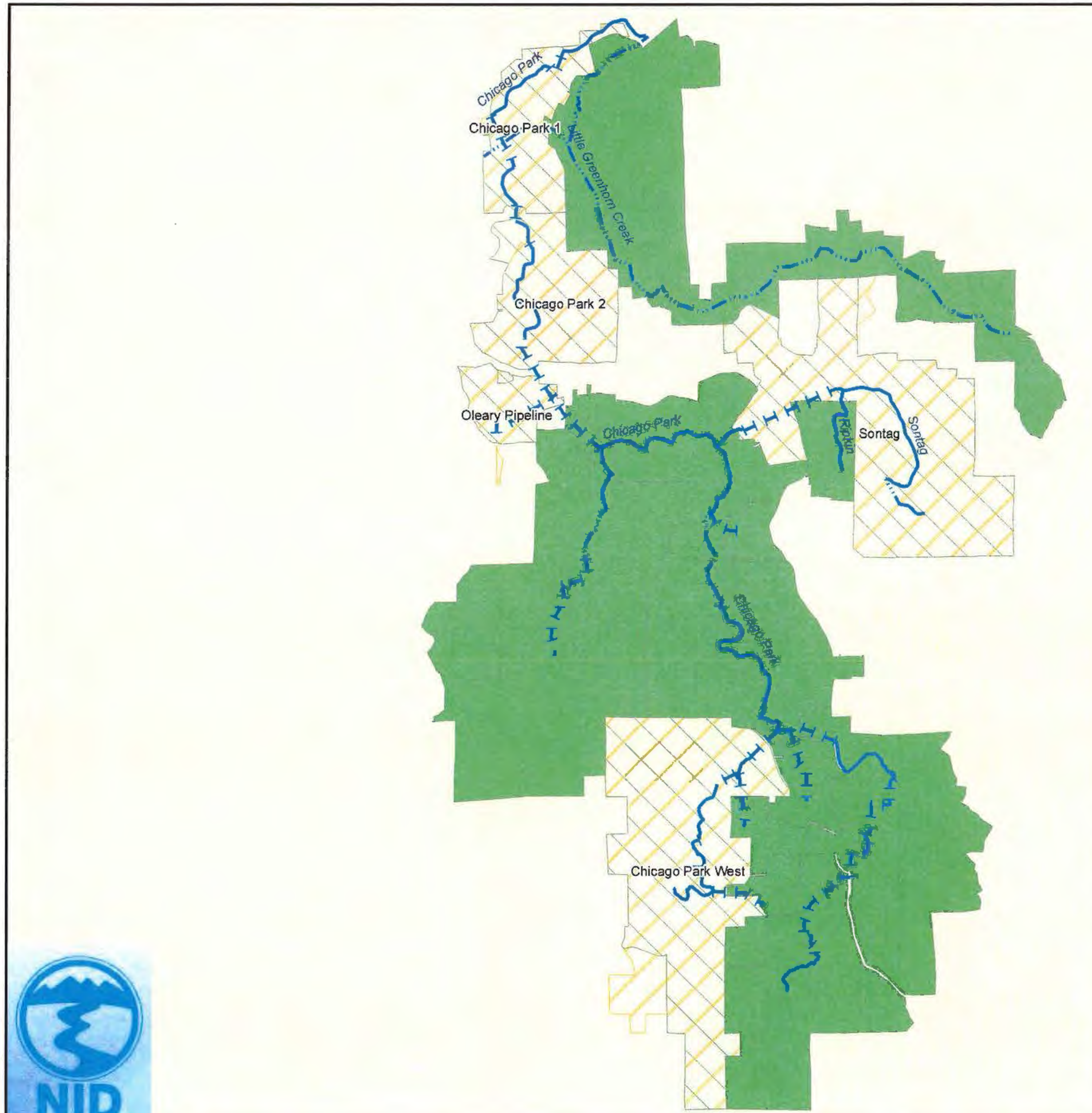
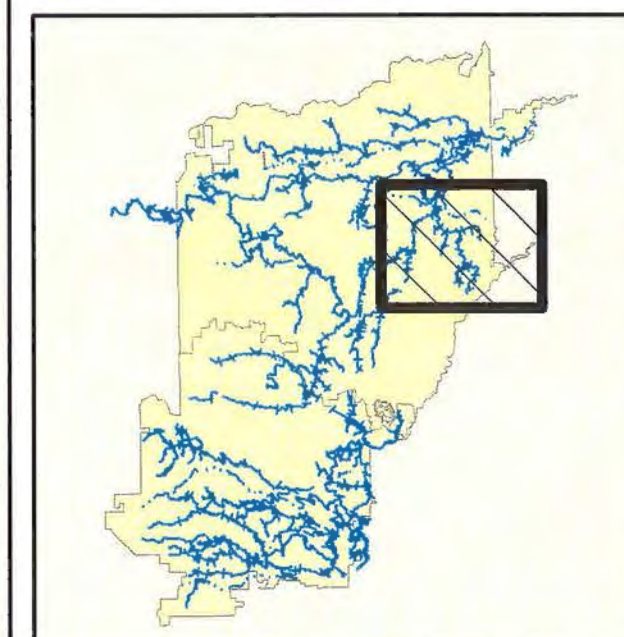
CHICAGO PARK SERVICE AREA CHANGES FROM PHASE 1

Figure A-7



For acreage changes table see lower right of map

Phase 2 Net Service Acreage Change	
Blum	-
Chicago Park 1	1.5
Chicago Park 2	(26.7)
Chicago Park 3	-
Chicago Park 4	-
Chicago Park East	-
Chicago Park West	85.8
John Henry Meyer	-
Little Greenhorn Creek	-
Meyers-Bierwagen	-
Oleary Pipeline	3.8
Ripkin	-
Ruess Pipeline	-
Smith Moulton	-
Sontag	15.0
Sunshine Valley	-



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RATTLESNAKE SERVICE AREA CHANGES FROM PHASE 1

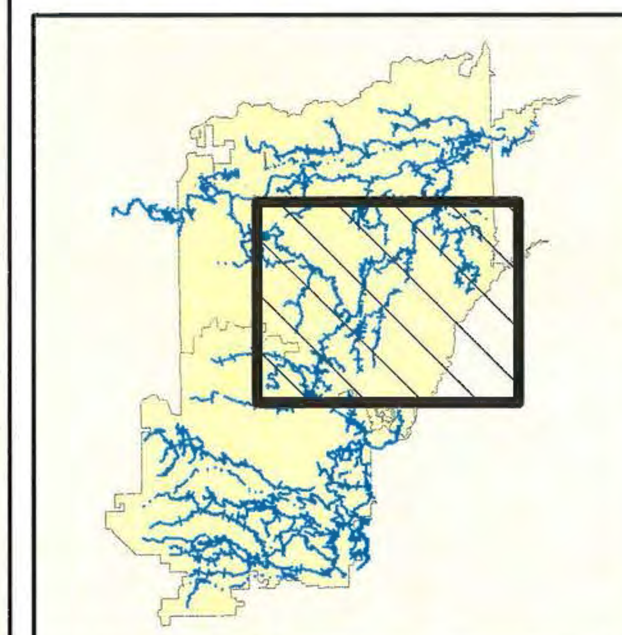
Figure A-8

- Canal
- Random/Creek
- Siphon/Pipe
- Tunnel
- No Change to Service Areas
- Phase 1 Service Area Boundaries
- Phase 2 Service Area Boundaries

0 3,250 6,500 13,000 Feet

Phase 2 Net Service Acreage Change	
Cherry Creek	2.6
Forest Springs	-
Grove	-
Kyler	-
Lower Maben	-
Maben-Ficket Pipeline	-
Rattlesnake 1*	-
Rattlesnake 2*	-
Rattlesnake 3*	-
Rattlesnake Above Cedar Crest Siphon	27.0
Upper Maben	9.5
Woodpecker	5.3

*Service areas split differently than Phase 1 though total area is the same.



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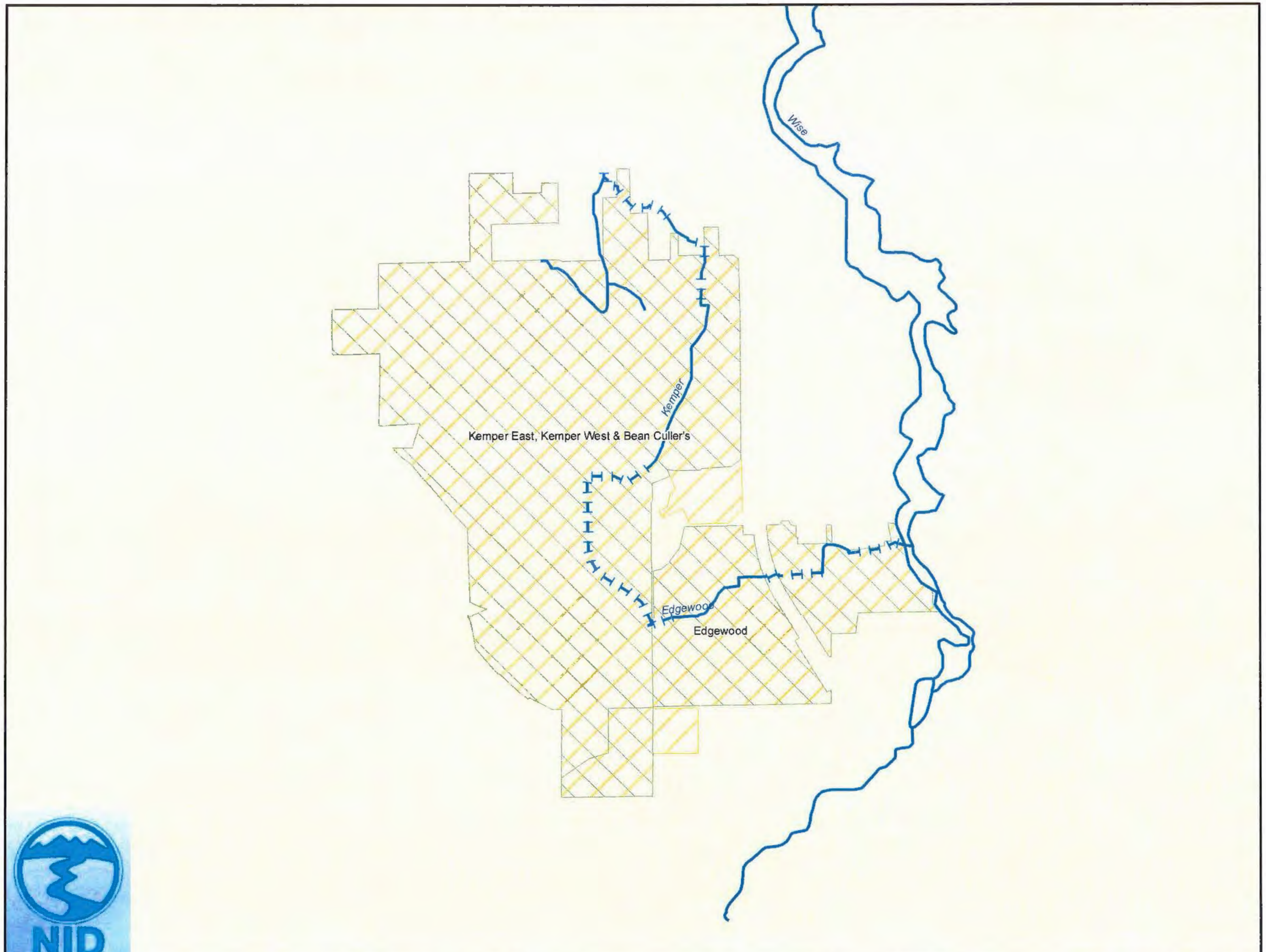
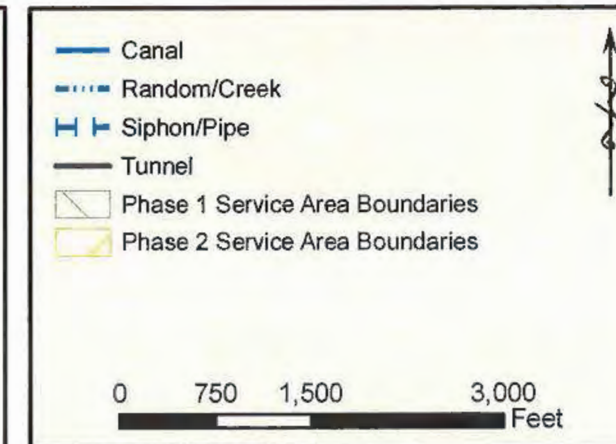
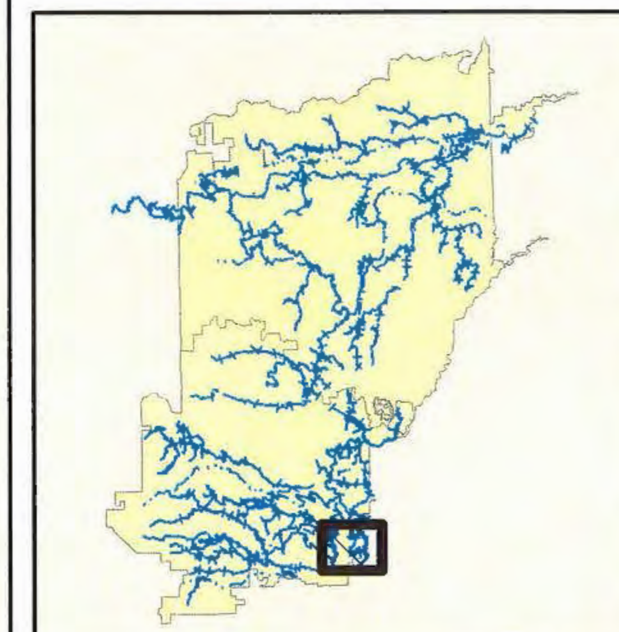
File: G:\NID_MXD\RWMP\Service Area Changes\Rattlesnake.mxd

KEMPER, BEAN CULLER'S & EDGEWOOD SERVICE AREA CHANGES FROM PHASE 1 Figure A-9





Phase 2 Net Service Acreage Change	
Edgewood	10.4
Kemper East, Kemper West & Bean Culler's	18.4



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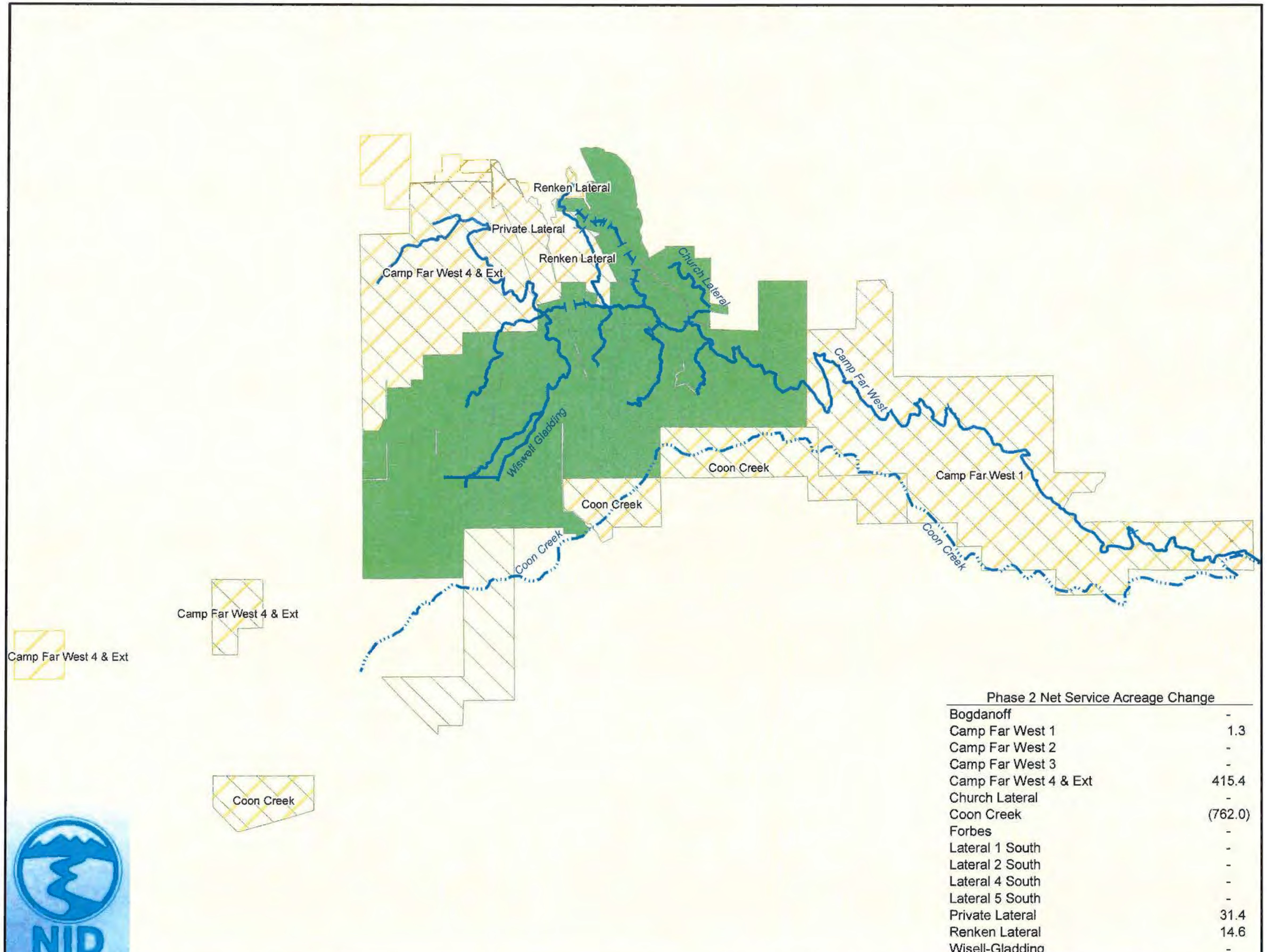
CAMP FAR WEST SERVICE AREA CHANGES FROM PHASE 1

Figure A-10

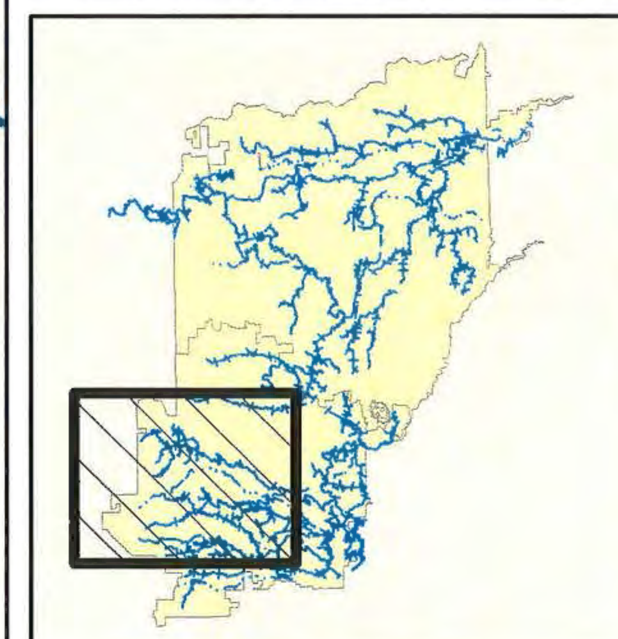


Phase 2 Net Service Acreage Change	
Bogdanoff	-
Camp Far West 1	1.3
Camp Far West 2	-
Camp Far West 3	-
Camp Far West 4 & Ext	415.4
Church Lateral	-
Coon Creek	(762.0)
Forbes	-
Lateral 1 South	-
Lateral 2 South	-
Lateral 4 South	-
Lateral 5 South	-
Private Lateral	31.4
Renken Lateral	14.6
Wisell-Gladding	-

Canal
Random/Creek
Siphon/Pipe
Tunnel
No Change to Service Areas
Phase 1 Service Area Boundaries
Phase 2 Service Area Boundaries

0 2,750 5,500 11,000 Feet

For acreage changes table see lower right of map



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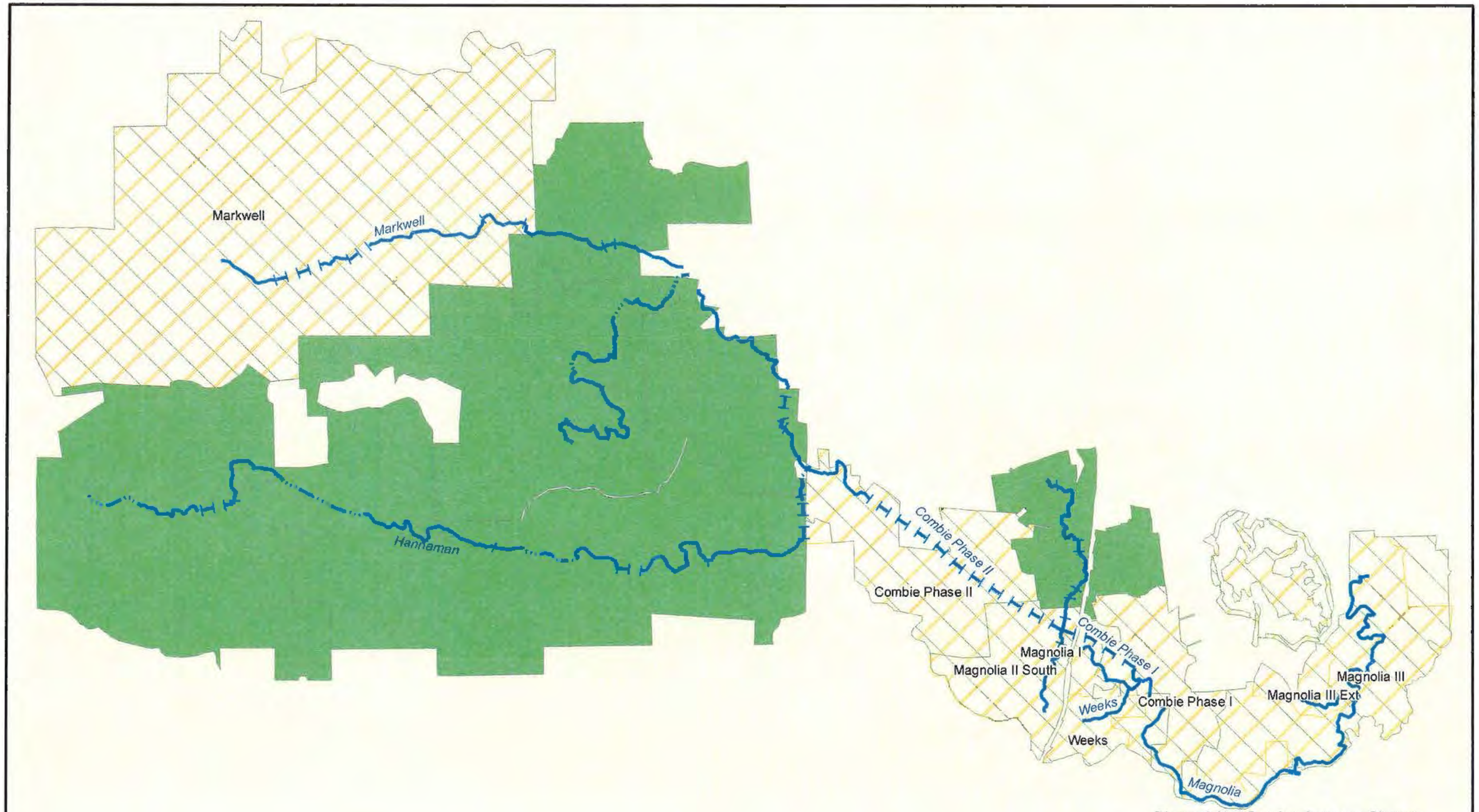
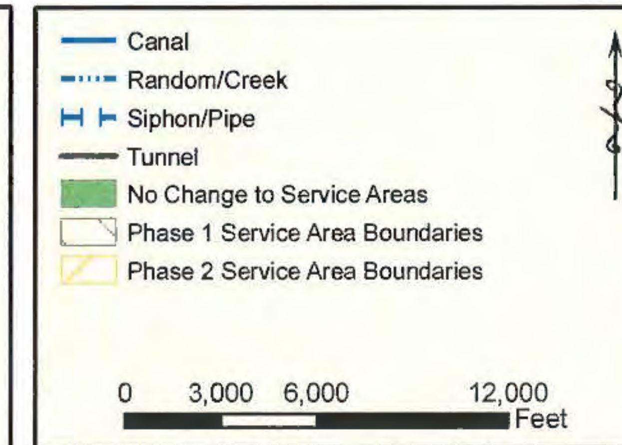
File: G:\NID_MXD\RWMP\Service Area Changes\Camp Far West.mxd

COMBIE SERVICE AREA CHANGES FROM PHASE 1

Figure A-11

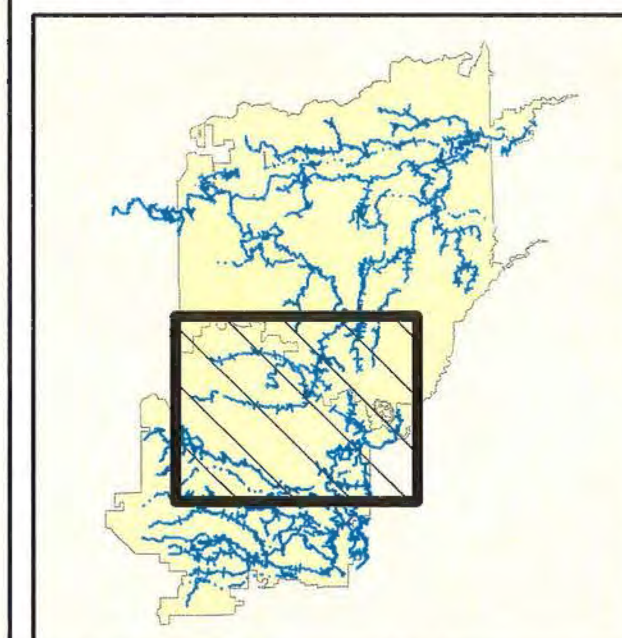




For acreage changes table see lower right of map

Phase 2 Net Service Acreage Change	
Combie Phase I*	296.5
Combie Phase II*	32.0
Combie Phase III	-
Hannaman I	-
Hannaman II	-
Magnolia I*	-
Magnolia II North	-
Magnolia II South	4.1
Magnolia III*	-
Magnolia III Ext*	(343.1)
Markwell	87.7
Sanford Struckman	-
Weeks*	(122.9)

*Service areas were separated in addition to being edited



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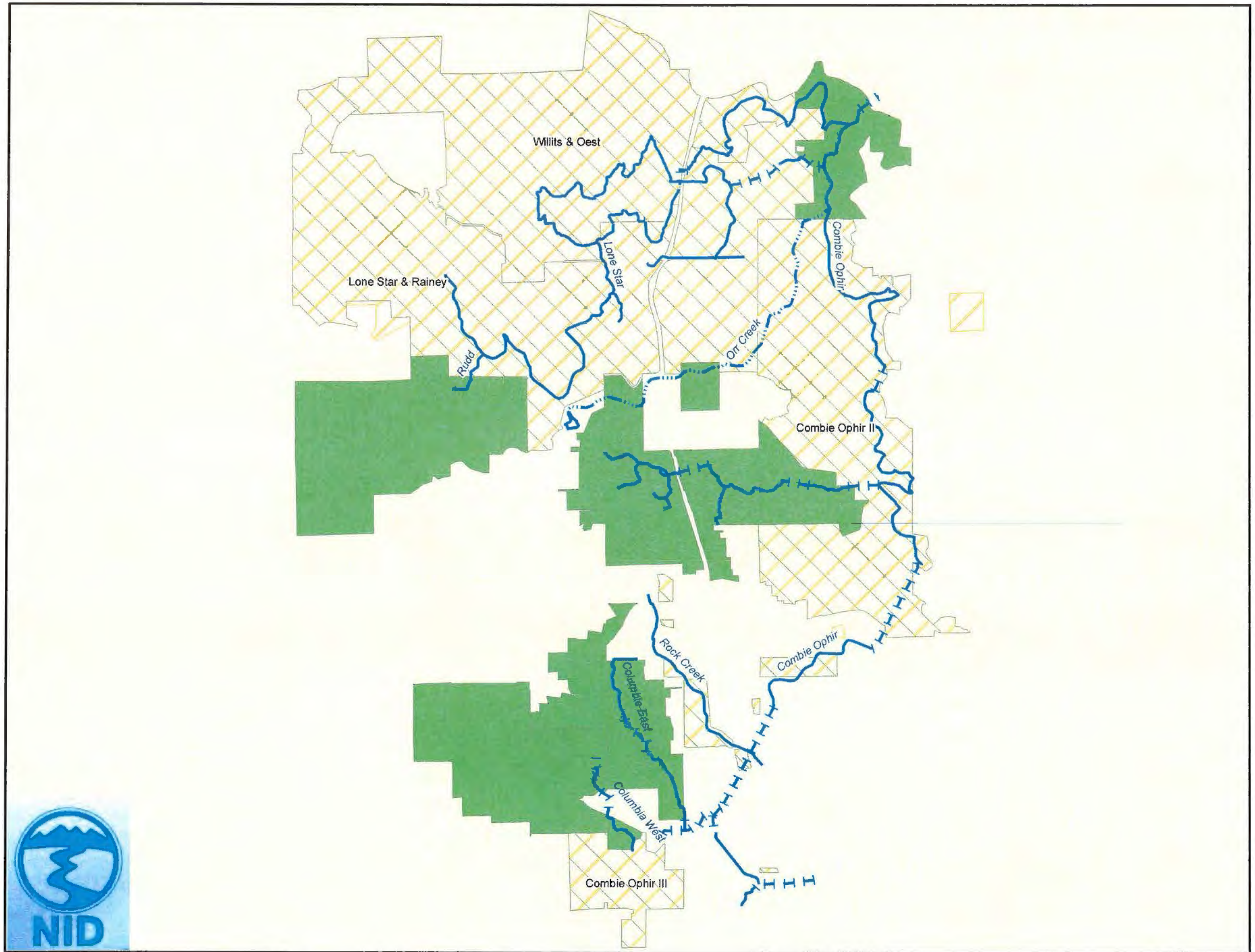
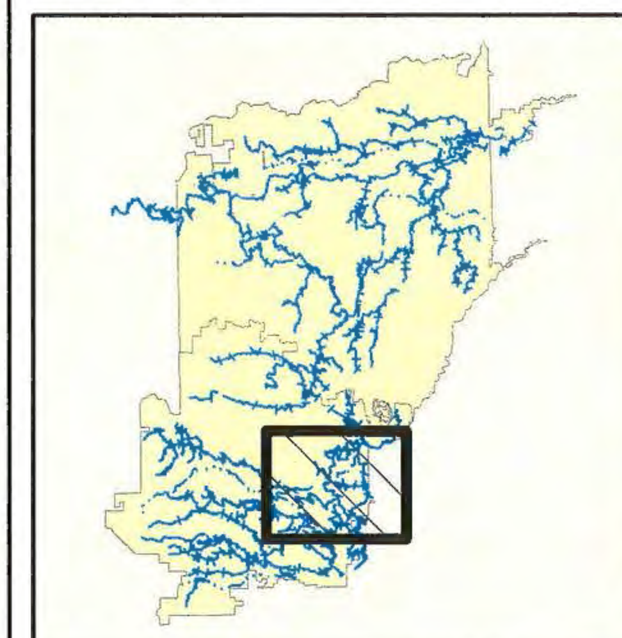
File: G:\NID_MXD\RWMP\Service Area Changes\Combie.mxd

COMBIE OPHIR I, II, & III SERVICE AREA CHANGES FROM PHASE 1

Figure A-12



Phase 2 Net Service Acreage Change	
Columbia East	-
Columbia West	-
Combie Ophir I	-
Combie Ophir II	39.8
Combie Ophir III	2.1
Lone Star & Rainey	23.6
Orr Creek Release	-
Pickett & Beck	-
Rudd	-
Willits & Oest	(3.8)



NID

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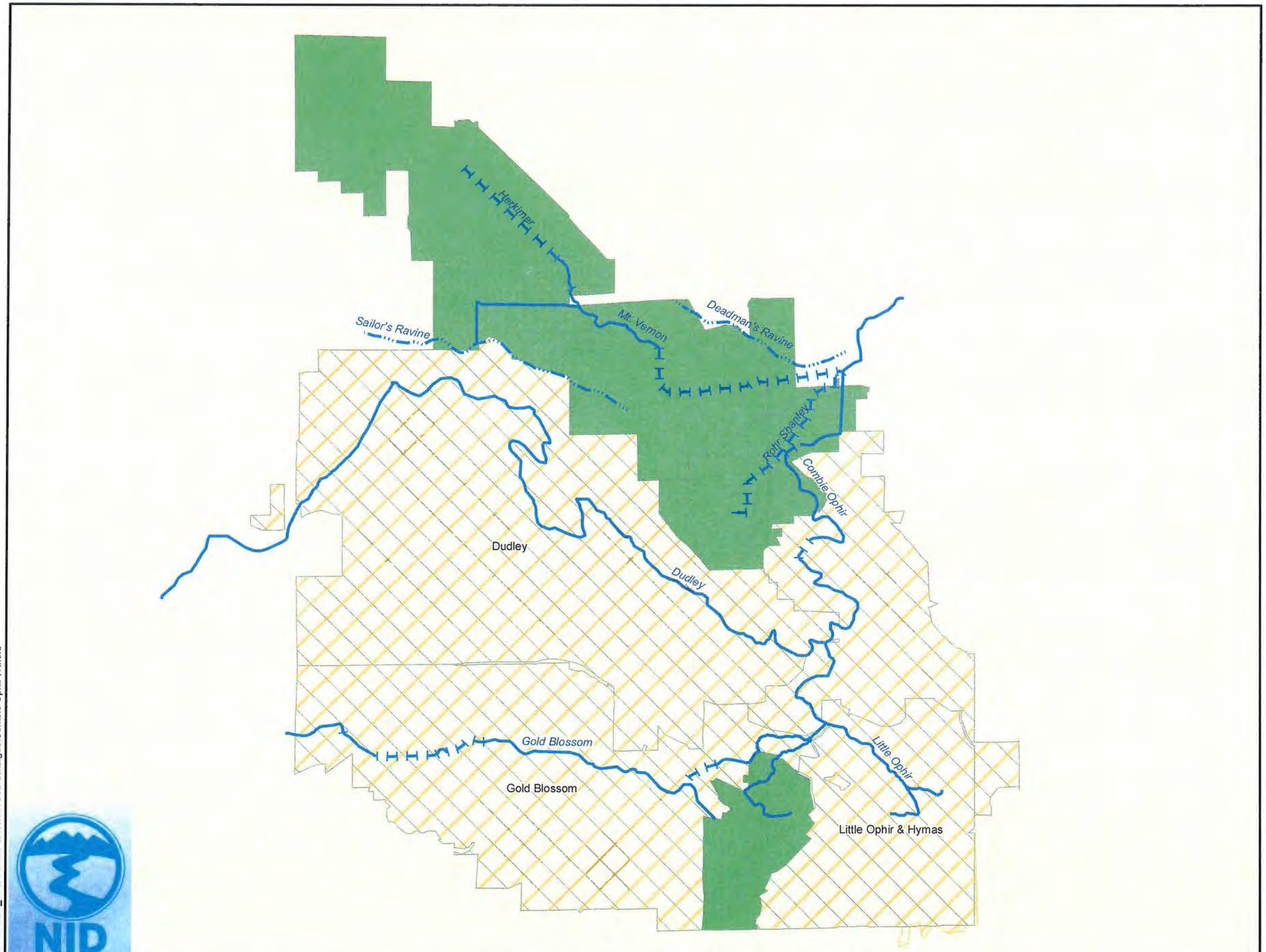
File: G:\NID_MXD\RWMP\Service Area Changes\Combie Ophir.mxd

COMBIE OPHIR IV SERVICE AREA CHANGES FROM PHASE 1

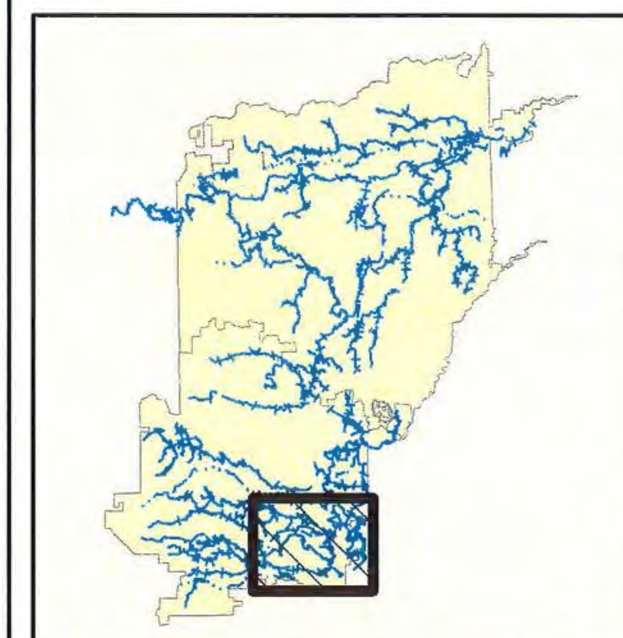
Figure A-13



- Canal
- Random/Creek
- Siphon/Pipe
- Tunnel
- No Change to Service Areas
- Phase 1 Service Area Boundaries
- Phase 2 Service Area Boundaries

0 1,500 3,000 6,000 Feet

Phase 2 Net Service Acreage Change	
Combie Ophir IV	-
Dudley	0.5
Gold Blossom	-
Little Ophir & Hymas	10.2
Mt. Vernon	-
Rohr-Shanley	-
St. Patrick's	-



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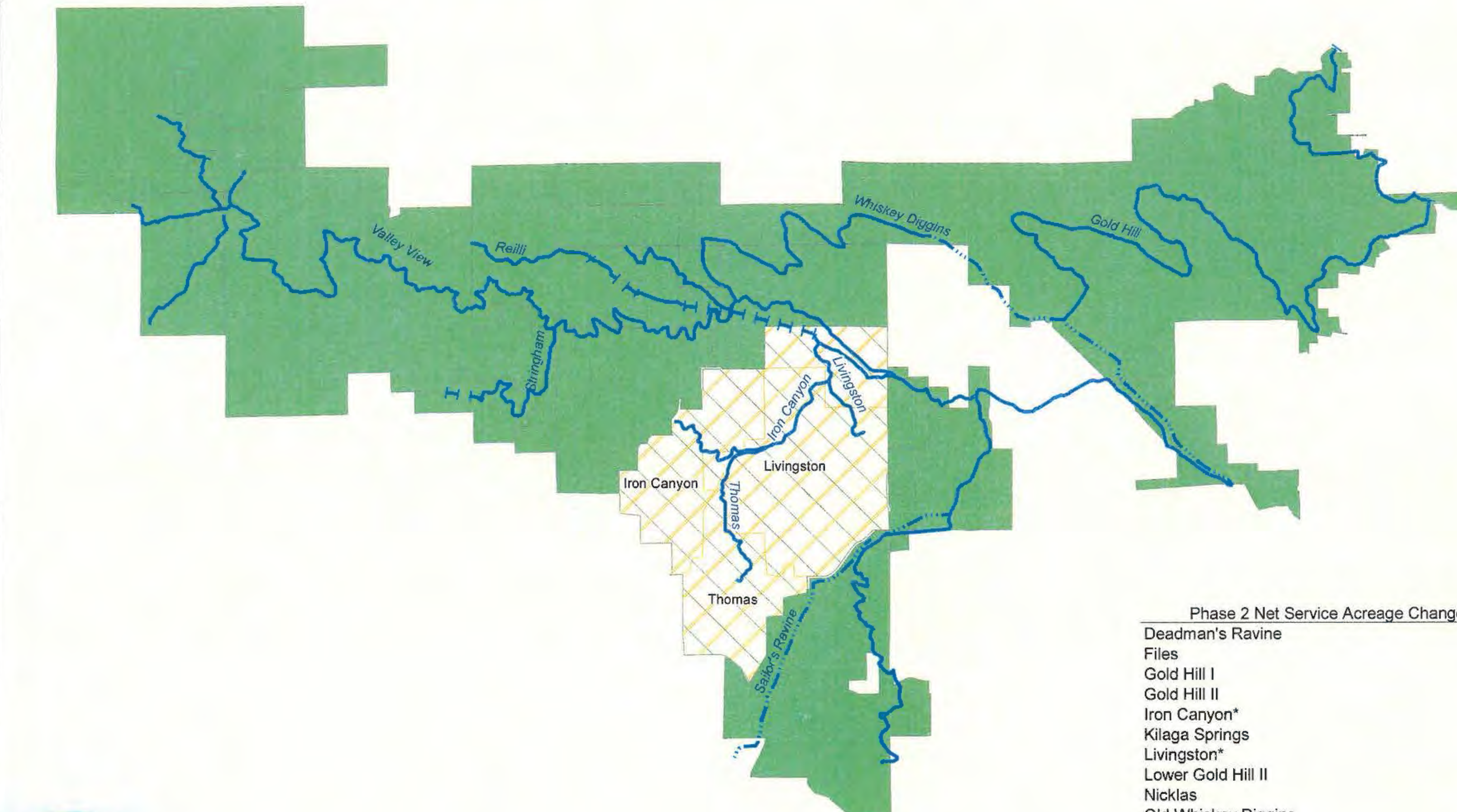
VALLEY VIEW & GOLD HILL SERVICE AREA CHANGES FROM PHASE 1

Figure A-14



Legend:

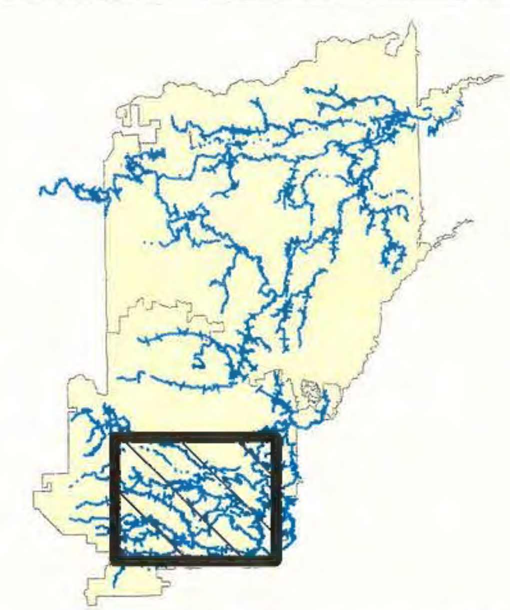
- Canal
- Random/Creek
- Siphon/Pipe
- Tunnel
- No Change to Service Areas
- Phase 1 Service Area Boundaries
- Phase 2 Service Area Boundaries

0 2,000 4,000 8,000 Feet

For acreage changes table see lower right of map

Phase 2 Net Service Acreage Change	
Deadman's Ravine	-
Files	-
Gold Hill I	-
Gold Hill II	-
Iron Canyon*	-
Kilaga Springs	-
Livingston*	-
Lower Gold Hill II	-
Nicklas	-
Old Whiskey Diggins	-
Reilli	-
Stringham	-
Thomas*	-
Valley View 1	-
Valley View 2	-
Valley View 3	-
Whiskey Diggins	-

*Service areas split. Total equals Phase 1.



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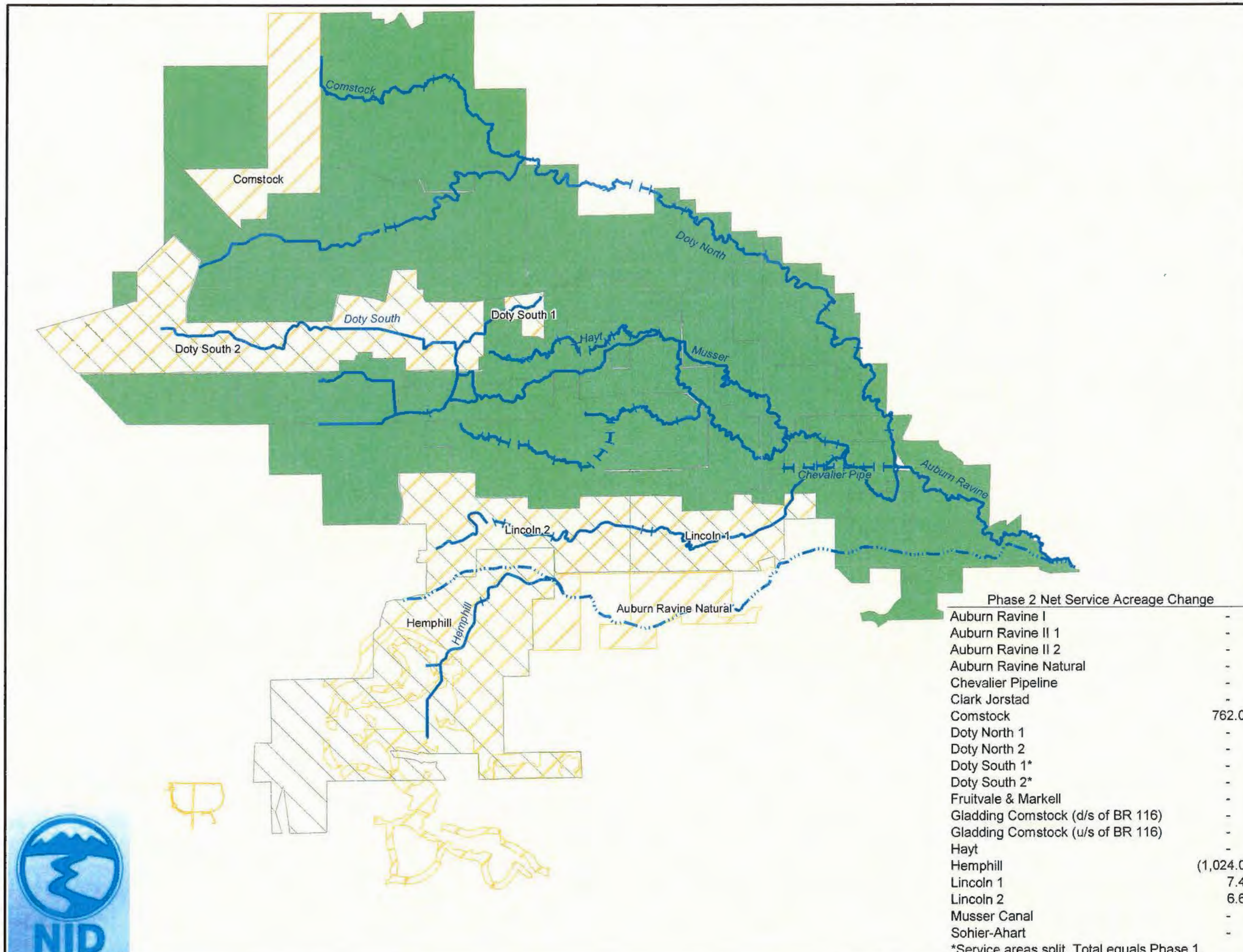
File: G:\NID_MXD\RWMP\Service Area Changes\Valley View & Gold Hill.mxd

AUBURN RAVINE SERVICE AREA CHANGES FROM PHASE 1

Figure A-15



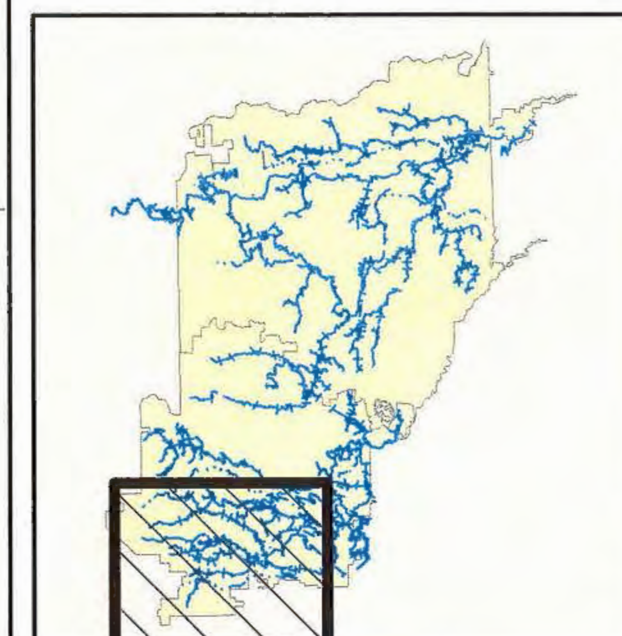
Phase 2 Net Service Acreage Change	
Auburn Ravine I	-
Auburn Ravine II 1	-
Auburn Ravine II 2	-
Auburn Ravine Natural	-
Chevalier Pipeline	-
Clark Jorstad	-
Comstock	762.0
Doty North 1	-
Doty North 2	-
Doty South 1*	-
Doty South 2*	-
Fruitvale & Markell	-
Gladding Comstock (d/s of BR 116)	-
Gladding Comstock (u/s of BR 116)	-
Hayt	-
Hemphill	(1,024.0)
Lincoln 1	7.4
Lincoln 2	6.6
Musser Canal	-
Sohier-Ahart	-

*Service areas split. Total equals Phase 1.

Canal
Random/Creek
Siphon/Pipe
Tunnel
No Change to Service Areas
Phase 1 Service Area Boundaries
Phase 2 Service Area Boundaries

0 0.5 1 2 Miles

For acreage changes table see lower right of map



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APPENDIX B

REGIONAL WATER TREATMENT FACILITY

ASSESSMENT OF REGIONAL WATER SUPPLY PROJECT DEMAND

Based on data developed by the Regional Water Supply Project (RWSP) Project Design Team, the initial average annual treatment plant demand anticipated for 2015 is approximately 3,700 acre-feet. At full build-out, occurring sometime after 2032, the anticipated total demand for the project is 16,755 acre-feet, which consists of 12,970 acre-feet for customers within the proposed City of Lincoln Sphere of Influence (SOI) and 3,786 acre-feet for the unincorporated soft service area (Table B-1, Figure B-1). Development of the project will affect land use within the proposed SOI, and potentially within the soft service area boundary determined for the project. As much of the area within the SOI currently receives raw water, the change in land use will result in a demand offset that will reduce the overall net demand for the proposed project (Figure B-2). For this analysis, it is assumed that the required demand will be supplied by the District.

As noted above, the proposed project demand will be partially offset as some of the parcels within the SOI are already receiving either treated District water through an agreement with the Placer County Water Agency (PCWA) or raw water via the District's canal system. Once the RWSP is on line, the District will provide these customers directly with treated water. In addition, it is assumed that raw water customers within the SOI will be converted from raw water to treated water customers. This represents a direct conversion and will not affect system demand.

TABLE B-1: SUMMARY OF SOI AREA DEMAND CALCULATIONS

Village	Canal	RW Acreage	Duty Rate (acre-feet/acre)	Current RW Demand (acre-feet)	Anticipated TW Demand (acre-feet)
Lincoln Crossing/Twelve Bridges	Hemphill	see note	1.79		
Lincoln Crossing/Twelve Bridges	Lincoln 2	1.33	2.63	3.50	
Lincoln Crossing/Twelve Bridges Total				3.50	3,145
Village 1	Auburn Ravine Natural				
Village 1	Hemphill	see note	1.79		
Village 1	Lincoln 2	12.29	2.63	32.32	
Village 1 Total				32.32	3,455
Village 2	Auburn Ravine II 2	476.74	2.28	1,086.98	
Village 2	Fruitvale &Markell	40.34	1.75	70.59	
Village 2	Lincoln 2	19.33	2.63	50.84	
Village 2	Sohier-Ahart	325.30	2.28	741.68	
Village 2 Total				1,950.09	2,560
Village 3	Auburn Ravine Natural	0.00			
Village 3	Clark Jorstad	75.03	1.46	109.54	
Village 3	Coon Creek	178.30	2.55	454.67	
Village 3	Doty South 2	809.34	1.49	1,205.92	
Village 3	Sohier-Ahart	0.00			
Village 3 Total				1770.14	3,810
GRAND TOTAL		1,938.01		3756.04	12,970
Average Duty			1.94		

Notes:

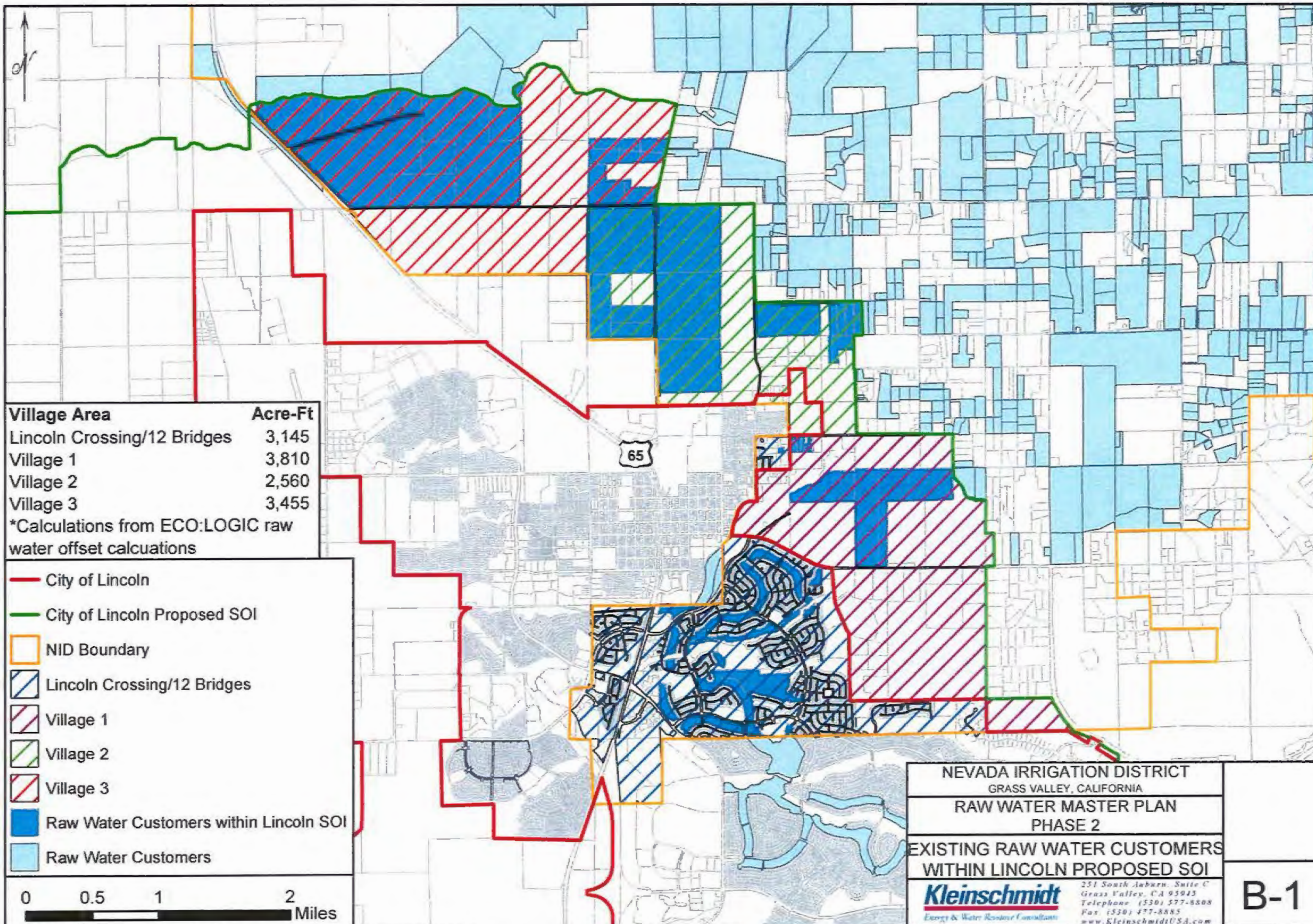
RW = raw water; TW = treated water

7,323 = Lincoln SOI acreage

1,938 = Acres in SOI currently receiving RW from NID

530 = Acres receiving raw water from Hemphill Canal in Lincoln Crossing area or outside District

2,313 = Raw water deliveries via Hemphill Canal to golf course and greenway (NID data)



N
65
Village Area | Acre-Ft
Lincoln Crossing/12 Bridges 3,145
Village 1 3,810
Village 2 2,560
Village 3 3,455
*Calculations from ECO:LOGIC raw water offset calcuations
City of Lincoln
City of Lincoln Proposed SOI
NID Boundary
Lincoln Crossing/12 Bridges
Village 1
Village 2
Village 3
Raw Water Customers within Lincoln SOI
Raw Water Customers
0 0.5 1 2
Miles
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GRASS VALLEY, CALIFORNIA
RAW WATER MASTER PLAN
PHASE 2
EXISTING RAW WATER CUSTOMERS
WITHIN LINCOLN PROPOSED SOI
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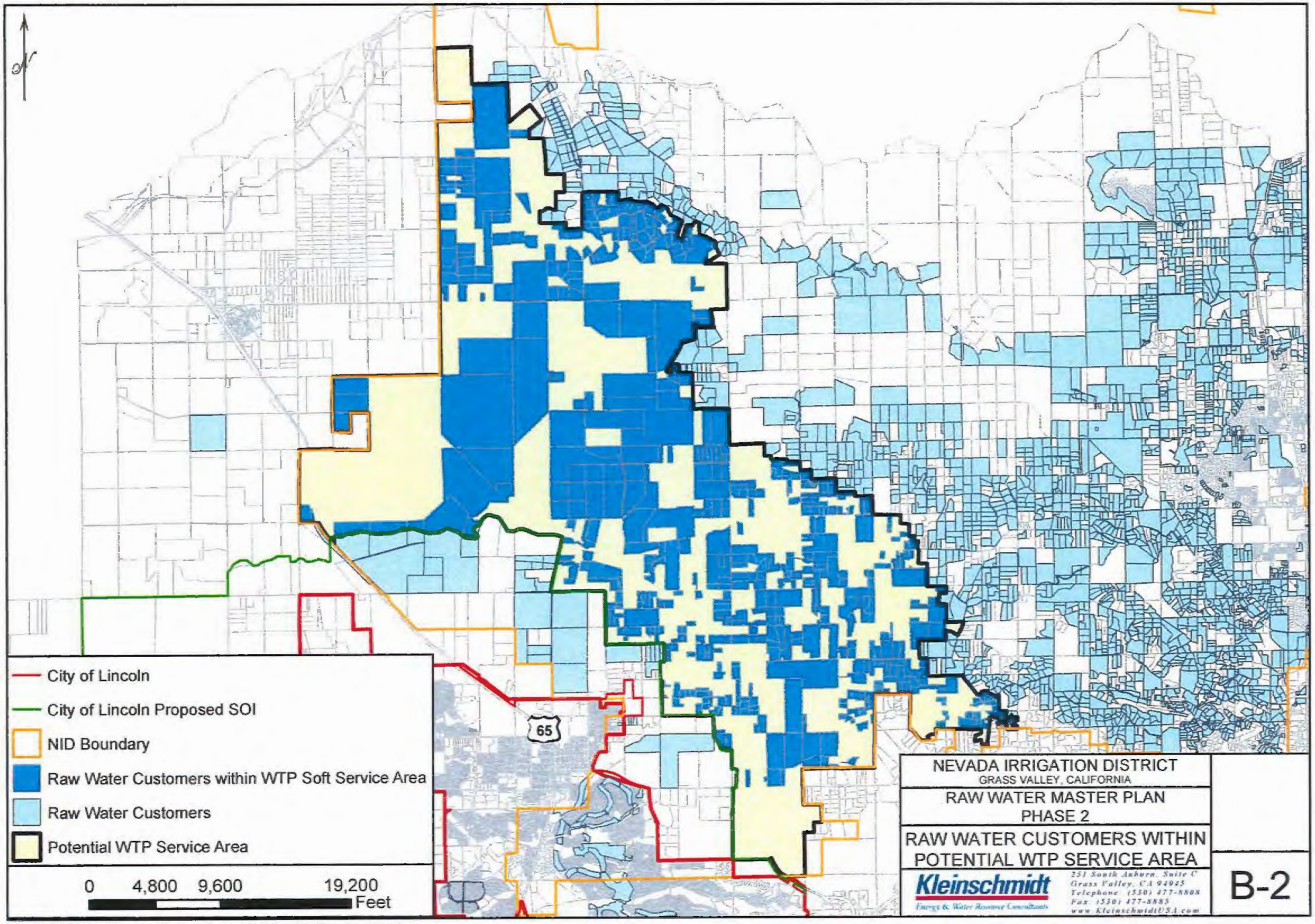

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Printing Date: 11/1/2011 Prepared By: SJC Project: 0894011.01

Using the SOI delineation provided by ECO:LOGIC[1], it was determined that the District currently provides raw water to 2,468 acres within the SOI. There are two exceptions: within the Lincoln Crossing area, raw water is provided via the Hemphill canal to a golf course and to a greenway area. District data shows that these two areas, which total approximately 530 acres, purchase 2,253 acre-feet of raw water during the irrigation season (518.7 acres with 1,542 acre-feet for the golf course, and 11.5 acres with 711 acre-feet for the greenway). Because it is anticipated that these deliveries will continue into the future, they were not included in the demand offset calculations. This results in a net raw water acreage total of 1,938 acres within the SOI, with a total net raw water demand of 3,756 acre-feet.

Growth projections are assumed constant at a rate of 2 percent per yearfor the parcels within the SOI currently receiving raw water from the District. Applying this growth rate, the raw water acreage is anticipated to increase from 1,938 acres to 2,226 acresby 2015. The corresponding raw water demand, using an average duty rate for the area of 1.94 acre-feet/acre, was computed to be 4,318 acre-feet. In addition, current annual water delivery to customers within the Lincoln area is approximately 1,700 acre-feet. Including this value with the estimated raw water demand that will be converted results in a total demand in 2015 of 6,018 acre-feet for current District customers within the proposed SOI. This figure is the anticipated offset that should be applied to the estimated treatment plant demand to determine estimated net demand for the project.

As mentioned previously, estimated demand for the SOI was reported by ECO:LOGIC as 12,970 acre-feet (see Table B-1). Applying the computed raw water and treated water demands as the offset (6,018 acre-feet) results in a net demand of 6,952 acre-feetin 2015.

Ultimately, flow to the project will be provided via a dedicated pipeline. Tapping the pipeline at select locations could provide raw water to areas that do not have reasonable access to the District's canal system. An analysis of the potential areas that could be served using the pipeline was performed using the pipeline alignment and hydraulic grade profile for Alignment 8A developed by ECO:LOGIC.

[1] ECO:LOGIC has since merged with Stantec.

The soft service area was derived using the following assumptions/criteria:

1. A maximum pressure limit of 150 PSI was used. There is some potential for increasing the hydraulic head on the pipeline by an additional 35 feet. This was reviewed, as was using the existing hydraulic profile for the service area.

2. "Change over" customers—NID customers who are currently receiving raw water from a canal—will not be considered eligible for raw water service from the pipeline.

3. Extensions from the conduit will be considered to run out a reasonable limit. This is a judgment call and in keeping within the soft service area philosophy used in the RWMP. For this analysis, the following assumptionswere used:

   a. For parcels that are upgradient to the pipeline, we have assumed 25 feet of headloss and a delivery tap pressure requirement of 20 PSI(or 46.2 feet of head). Removing these 71.2 feet from the hydraulic gradeline determined the elevation to which service could be provided. Typically, the upgradient distances are very short.

   b. For parcels that are down gradient, we have initially selected 2,500 feet as a reasonable approximate extension unless a road crossing or other obstacle is encountered, in which case the extension will not extend beyond the obstacle.

Based on these assumptions/criteria, we have established a soft service area boundary for the pipeline as depicted in Figure B-3. The proposed pipeline routing also passes through an Exclusion zone (shown as the hatched area on Figure B-3), which falls within the noted criteria for service from the pipeline. Combining the Exclusion areas with the area of parcels within the existing canal service areasnoted in Table B-2 results in a total potential pipeline service area of 5,536 acres. Using a conservative duty rate of 2 acre-feet/acre, the raw water demand for parcels within District boundaries, and within the current canal soft service areaboundary, would be approximately 16 cfs.

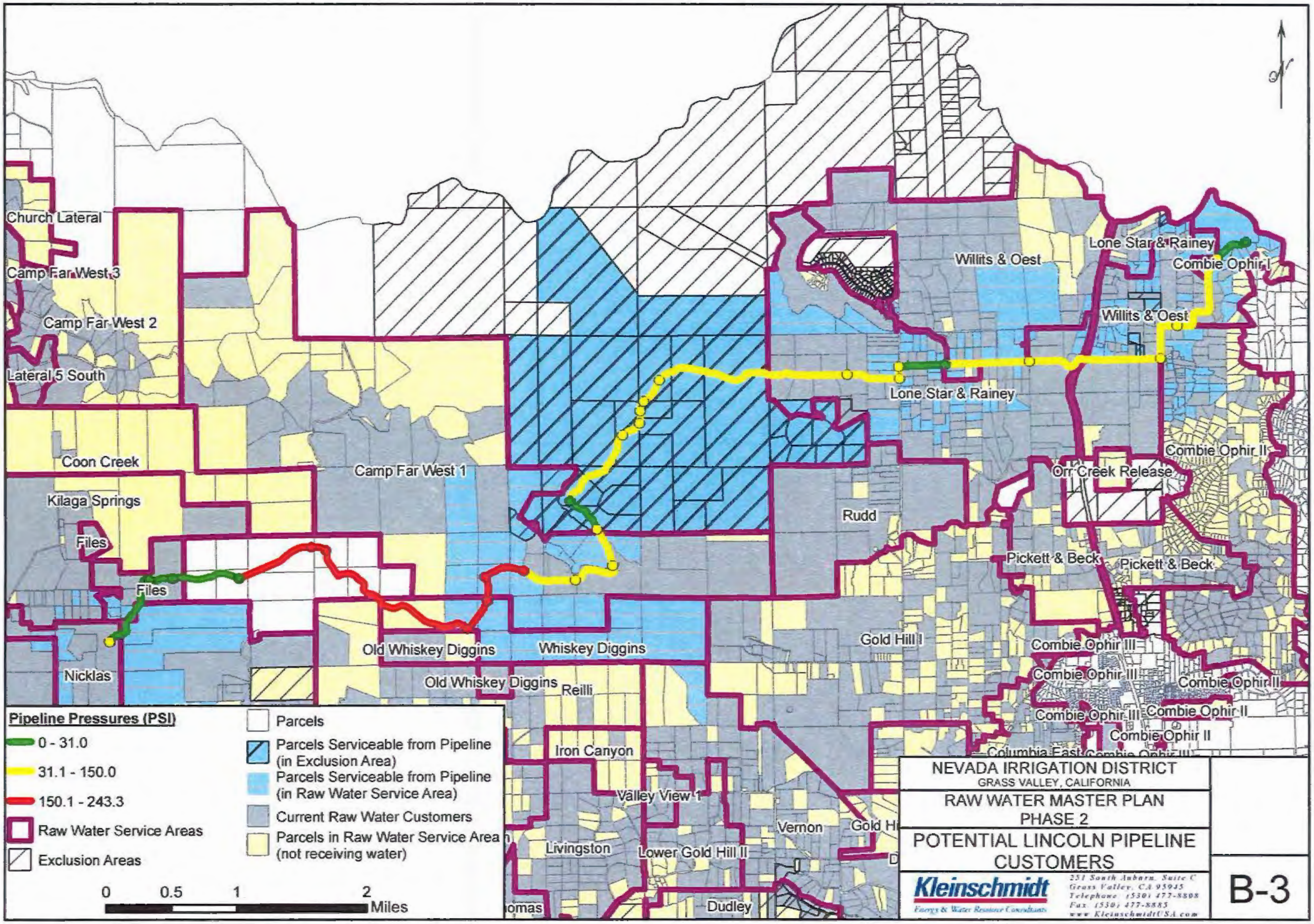
TABLE B-2: POTENTIAL PIPELINE SOFT SERVICE AREA WITHIN RAW WATER CANAL SERVICE AREAS

CANAL AREA	ACREAGE	NO. OF PARCELS
Camp Far West	607	20
Combie Ophir I	261	13
Combie Ophir II	93	27

Doty North	0.03	1
Files	28	4
Kilaga Springs	23	3
Lone Star and Rainey	414	61
Nicklas	81	3
Valley View	447	3
Whiskey Diggins	549	9
Willits & Oest	451	54
Total	**2,954**	**198**

The potential pipeline service area within the noted Exclusion area totals 2,582 acres. There is the possibility that some or all of this area may fall under the Railroad Commission Order #RCO-26098, PG&E Gold Hill System, as it borders the Camp Far West Canal. If so, the Order states that parcels within this area are entitled to 1 MI of irrigation water without annexation. This would total approximately 35 MI, or approximately 1 cfs (363 acre-feet). The Order states that parcels wishing to purchase additional water will be allowed to do so providing that the land is annexed at the current fees, tolls, and charges for annexation. Assuming annexation of soft service area within the exclusion area, and applying the 2 acre-feet per acre duty rate, the raw water demand would be approximately 14 cfs or 5,164 acre-feet.

Two issues require consideration when providing raw water service from the pipeline pipeline capacity (pipe size) and the overall demand on the system. Concerning demand, the potential pipeline soft service areas noted in Table B-2 are already included in the demand-forecasting model as they are within existing canal soft service areas. If improvements are implemented to increase capacity in the canal segments noted in Table B-2, these areas may/could then become served by the canal, reducing the impact on the pipeline. Therefore, providing water to these parcels would have limited impact on the overall system demand total.


Church Lateral
Camp Far West 3
Camp Far West 2
Lateral 5 South
Coon Creek
Kilaga Springs
Files
Files
Nicklas
Camp Far West 1
Old Whiskey Diggins
Whiskey Diggins
Old Whiskey Diggins
Reilli
Iron Canyon
Valley View 1
Livingston
Lower Gold Hill II
Vernon
Dudley
Rudd
Gold Hill I
Willits & Oest
Willits & Oest
Lone Star & Rainey
Lone Star & Rainey
Combie Ophir I
Combie Ophir II
Orr Creek Release
Pickett & Beck
Pickett & Beck
Combie Ophir III
Combie Ophir III
Combie Ophir II
Combie Ophir III
Combie Ophir II
Combie Ophir II
Pipeline Pressures (PSI)
0 - 31.0
31.1 - 150.0
150.1 - 243.3
Raw Water Service Areas
Exclusion Areas
Parcels
Parcels Serviceable from Pipeline (in Exclusion Area)
Parcels Serviceable from Pipeline (in Raw Water Service Area)
Current Raw Water Customers
Parcels in Raw Water Service Area (not receiving water)
0
0.5
1
2
Miles
NEVADA IRRIGATION DISTRICT
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RAW WATER MASTER PLAN
PHASE 2
POTENTIAL LINCOLN PIPELINE CUSTOMERS
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The noted Exclusion area is not within a current canal service area. Assuming full build-out demand for exclusion areas noted in the pipeline soft service area, the total additional demand could potentially be 14 cfs or approximately 5,164 acre-feet of water. Planning for this demand level would result in a substantial increase in flows in the pipeline that could necessitate an increase in pipe size.

Potential demand noted for the pipeline requires completion of the pipeline system. As this is well into the future, this demand was not added to the demand projections in this analysis.

APPENDIX C

DEMAND ANALYSIS RESULTS FOR 2007–2032

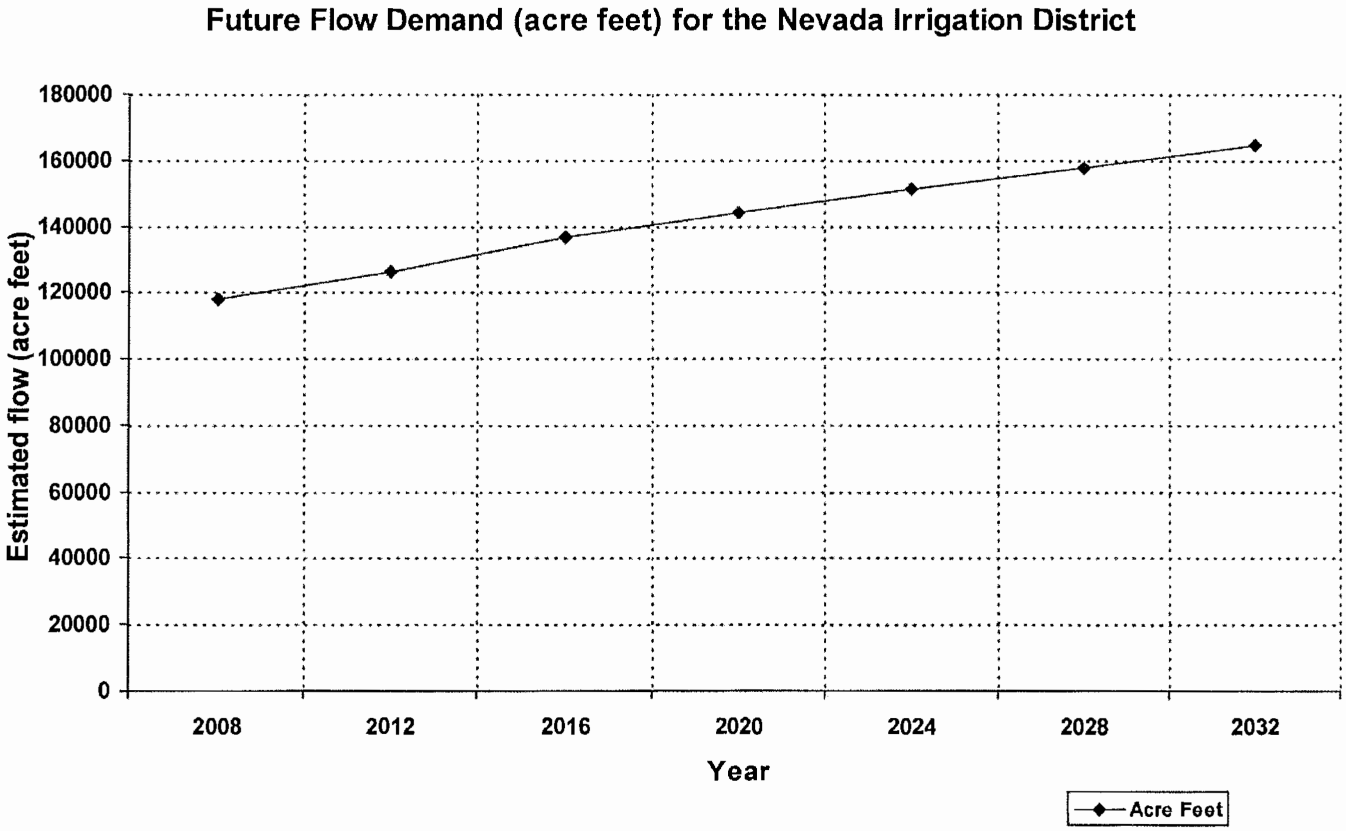
Nevada Irrigation District
Irrigation Season Raw Water Demand Model
District Results Page

Estimated Annual Demand (Acre Feet)

2008	2012	2016	2020	2024	2028	2032
117750	126311	136677	143897	151410	157690	164533

Estimated Average Canal Flows (cfs)

2008	2012	2016	2020	2024	2028	2032
325	348	376	396	417	435	453



Nevada Irrigation District
Irrigation Season Raw Water Demand Model
System Results Page

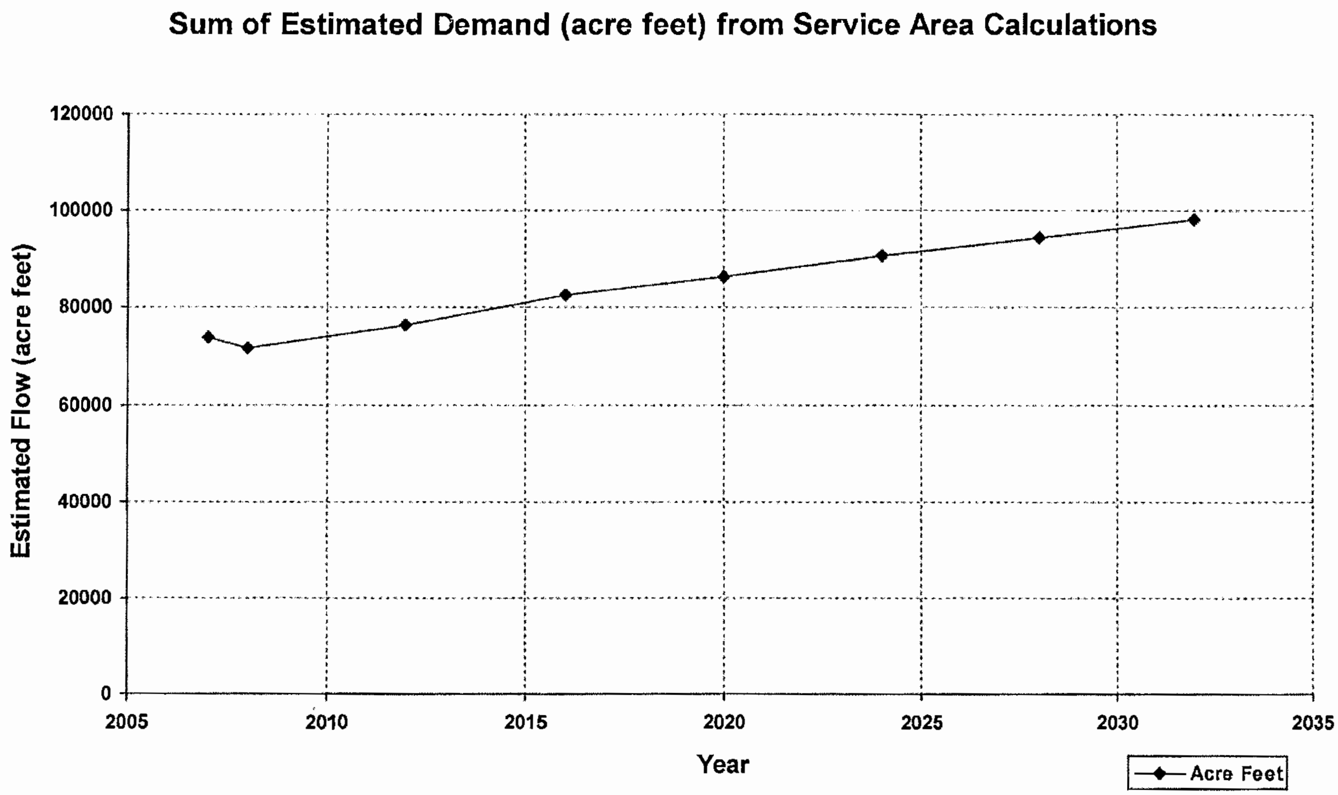
Bear River

Estimated Annual Demand (Acre Feet)

2008	2012	2016	2020	2024	2028	2032
71817	76302	82573	86445	90777	94296	98141

Estimated Average Flow (cfs)

2008	2012	2016	2020	2024	2028	2032
198	210	227	238	250	260	270



To make another selection you must first close this form

Printable on 8.5" x 11" paper

Nevada Irrigation District
Irrigation Season Raw Water Demand Model
System Results Page

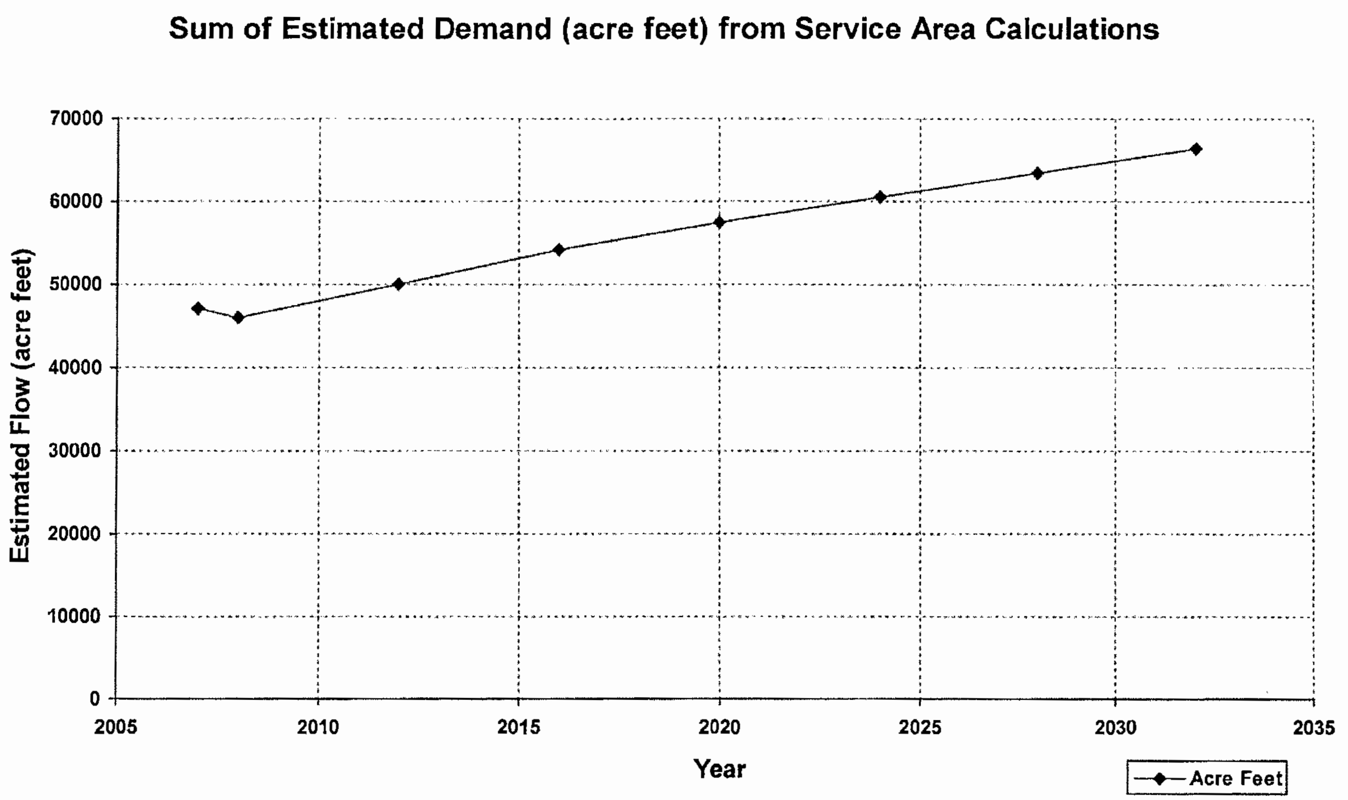
Deer Creek

Estimated Annual Demand (Acre Feet)

2008	2012	2016	2020	2024	2028	2032
45933	50009	54104	57452	60633	63394	66392

Estimated Average Flow (cfs)

2008	2012	2016	2020	2024	2028	2032
127	138	149	158	167	175	183



To make another selection you must first close this form

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Nevada Irrigation District
Model Summary Page

2007

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	40	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	56	10
Deer Creek Natural:	34	9
System Total(cfs):	130	42
System Total (acre feet):	47065	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	102	38
Fiddler Green:	10	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	65	9
Rock Creek Delivery (YB086):	25	4
System Total (cfs):	203	53
System Total (acre feet):	73813	19178
Seasonal Sub Total:	120879	34278
System Sub Total:		155157
Environmental Flow:		7700
2007 Total System Demand:		162857

Nevada Irrigation District
Model Summary Page

2008

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	43	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	49	10
Deer Creek Natural:	35	9
System Total(cfs):	127	42
System Total (acre feet):	45933	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	125	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	61	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	198	49
System Total (acre feet):	71817	17846
Seasonal Sub Total:	117749	32946
	System Sub Total:	150695
	Environmental Flow:	7700
	2008 Total System Demand:	158395

Nevada Irrigation District
Model Summary Page

2012

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	49	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	53	10
Deer Creek Natural:	36	9
System Total(cfs):	138	42
System Total (acre feet):	50009	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	133	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	66	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	210	49
System Total (acre feet):	76302	17846
Seasonal Sub Total:	126310	32946
System Sub Total:		159256
Environmental Flow:		7700
2012 Total System Demand:		166956

Nevada Irrigation District
Model Summary Page

2016

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	55	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	56	10
Deer Creek Natural:	37	9
System Total(cfs):	149	42
System Total (acre feet):	54104	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	145	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	71	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	227	49
System Total (acre feet):	82573	17846
Seasonal Sub Total:	136676	32946
System Sub Total:		169622
Environmental Flow:		7700
2016 Total System Demand:		177322

Nevada Irrigation District
Model Summary Page

2020

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	60	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	60	10
Deer Creek Natural:	39	9
System Total(cfs):	158	42
System Total (acre feet):	57452	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	151	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	76	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	238	49
System Total (acre feet):	86445	17846
Seasonal Sub Total:	143897	32946
System Sub Total:		176843
Environmental Flow:		7700
2020 Total System Demand:		184543

Nevada Irrigation District
Model Summary Page

2024

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	64	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	63	10
Deer Creek Natural:	40	9
System Total(cfs):	167	42
System Total (acre feet):	60633	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	159	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	80	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	250	49
System Total (acre feet):	90777	17846
Seasonal Sub Total:	151410	32946
	System Sub Total:	184356
	Environmental Flow:	7700
	2024 Total System Demand:	192056

Nevada Irrigation District
Model Summary Page

2028

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	66	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	67	10
Deer Creek Natural:	42	9
System Total(cfs):	175	42
System Total (acre feet):	63394	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	165	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	84	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	260	49
System Total (acre feet):	94296	17846
Seasonal Sub Total:	157690	32946
System Sub Total:		190636
Environmental Flow:		7700
2028 Total System Demand:		198336

Nevada Irrigation District
Model Summary Page

2032

System	Irrigation Season	Winter Season
Deer Creek		
Cascade System:	68	23
D/S (Deer Creek South Canal to D.S. Ext Pumps):	71	10
Deer Creek Natural:	44	9
System Total(cfs):	183	42
System Total (acre feet):	66392	15100
Bear River		
Combie Phase 1 (Dam to Bear River Siphon):	173	38
Fiddler Green:	11	2
Auburn Ravine Natural (Wise P.H. to Hwy 65:	86	9
Rock Creek Delivery (YB086):	0	0
System Total (cfs):	270	49
System Total (acre feet):	98141	17846
Seasonal Sub Total:	164534	32946
	System Sub Total:	197480
	Environmental Flow:	7700
	2032 Total System Demand:	205180

Summary of RWMP Estimated Flows for the Snow Mountain System (in cfs)

Schematic: D1

Calibration Year: 2007

Snow Mountain Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Cement Hill 1	0.37	0.34	0.71	0.80	0.19	0.18	0.19	0.19	0.19	0.19	0.19	0.19	1.27	0.24	0.23	0.25	0.25	0.25	0.25	0.25	0.25
Cement Hill 2	0.37	0.34	0.49	0.80	1.19	1.13	1.23	1.33	1.44	1.55	1.68	1.68	1.27	1.51	1.44	1.56	1.69	1.83	1.98	2.14	2.14
Lake Vera Pipe	0.37	0.34	0.67	0.67	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	1.27	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Red Hill 1	1.41	1.53	0.46	0.80	0.45	0.49	0.51	0.53	0.53	0.53	0.53	0.53	1.33	0.59	0.65	0.67	0.70	0.70	0.70	0.70	0.70
Red Hill 2	1.41	1.53	0.28	0.80	0.52	0.57	0.62	0.67	0.72	0.78	0.78	0.78	1.33	0.68	0.76	0.82	0.89	0.96	1.04	1.04	1.04
Red Hill Reservoir & Buffington	1.41	1.53	0.28	0.80	0.14	0.16	0.17	0.18	0.20	0.22	0.23	0.25	1.33	0.19	0.21	0.23	0.24	0.26	0.29	0.31	0.34
Snow Mountain 1	0.84	0.88	0.30	0.69	0.55	0.59	0.64	0.69	0.75	0.81	0.87	0.95	1.25	0.69	0.73	0.79	0.86	0.93	1.01	1.09	1.18
Snow Mountain 2	0.84	0.88	0.23	0.58	0.20	0.21	0.23	0.25	0.27	0.29	0.31	0.34	1.25	0.25	0.26	0.28	0.31	0.33	0.36	0.39	0.42
Snow Mountain 3	0.84	0.88	0.35	0.79	0.19	0.21	0.22	0.24	0.26	0.28	0.31	0.33	1.25	0.24	0.26	0.28	0.30	0.33	0.35	0.38	0.41
Sugarloaf Reservoir	0.84	0.88	0.61	0.80	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	1.25	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Willow Valley	0.84	0.88	0.35	0.80	0.12	0.12	0.13	0.14	0.16	0.16	0.16	0.16	1.25	0.15	0.15	0.17	0.18	0.20	0.20	0.20	0.20

Summation of Flows Below Snow Mountain Siphon (DC118) (Including Snow Mountain Canal, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Snow Mountain Canal below Snown Mountain Siphon (DC118)	3.84	3.88	3.82	3.93	4.21	4.50	4.79	5.09	5.35	5.49	4.78	4.91	5.26	5.63	5.99	6.36	6.69	6.86
Snow Mountain I			0.55	0.59	0.64	0.69	0.75	0.81	0.87	0.95	0.69	0.74	0.80	0.86	0.94	1.01	1.09	1.19
Willow Valley			0.12	0.12	0.13	0.14	0.16	0.16	0.16	0.16	0.15	0.15	0.16	0.18	0.20	0.20	0.20	0.20
Snow Mountain d/s of Willow Valley Canal			3.15	3.22	3.44	3.67	3.89	4.13	4.32	4.39	3.94	4.03	4.30	4.59	4.86	5.16	5.40	5.49
Snow Mountain II			0.20	0.21	0.23	0.25	0.27	0.29	0.31	0.34	0.25	0.26	0.29	0.31	0.34	0.36	0.39	0.43
Snow Mountain at Tunnel Outlet (North Bloomfield Road)			2.95	3.01	3.22	3.42	3.62	3.84	4.01	4.05	3.69	3.76	4.03	4.28	4.53	4.80	5.01	5.06
Snow Mountain III			0.19	0.21	0.22	0.24	0.26	0.28	0.31	0.33	0.24	0.26	0.28	0.30	0.33	0.35	0.39	0.41
Sugarloaf Reservoir			0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
Red Hill at Head (DC117)	1.11	1.20	1.11	1.21	1.29	1.38	1.45	1.53	1.54	1.56	1.48	1.61	1.72	1.84	1.93	2.03	2.05	2.07
Red Hill I			0.45	0.49	0.51	0.53	0.53	0.53	0.53	0.53	0.60	0.65	0.68	0.70	0.70	0.70	0.70	0.70
Red Hill d/s of Exclusion Area			0.66	0.73	0.79	0.85	0.92	1.00	1.02	1.03	0.88	0.97	1.05	1.13	1.22	1.33	1.36	1.37
Red Hill II			0.52	0.57	0.62	0.67	0.72	0.78	0.78	0.78	0.69	0.76	0.82	0.89	0.96	1.04	1.04	1.04
Red Hill at Red Hill Reservoir			0.14	0.16	0.17	0.18	0.20	0.22	0.23	0.25	0.19	0.21	0.23	0.24	0.27	0.29	0.31	0.33
Cement Hill at Head (DC171)	1.62	1.53	1.61	1.54	1.65	1.75	1.86	1.98	2.11	2.11	2.04	1.96	2.10	2.22	2.36	2.51	2.68	2.68
Cement Hill I			0.19	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.23	0.24	0.24	0.24	0.24	0.24	0.24
Lake Vera Pipe			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Cement Hill II d/s of Lake Vera Pipe			1.19	1.13	1.23	1.33	1.44	1.55	1.68	1.68	1.51	1.44	1.56	1.69	1.83	1.97	2.13	2.13

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Summary of RWMP Estimated Flows for the Newtown System (in cfs)

Schematic:
D2

Calibration Year: 2007

Newtown Estimated Flows
(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Lester	1.07	1.21	0.29	0.37	1.20	1.37	1.42	1.48	1.54	1.60	1.67	1.74	1.22	1.47	1.67	1.74	1.81	1.88	1.96	2.04	2.12
Newtown 1	1.15	1.84	0.28	0.55	2.16	3.50	3.64	3.79	3.94	4.10	4.27	4.44	1.23	2.65	4.30	4.48	4.66	4.85	5.05	5.25	5.46
Newtown 2	0.51	0.42	0.42	0.54	3.98	3.29	3.42	3.56	3.71	3.86	4.01	4.18	1.25	4.97	4.10	4.27	4.44	4.63	4.81	5.01	5.21
Newtown 3	2.04	1.95	0.24	0.39	1.56	1.50	1.56	1.63	1.69	1.76	1.83	1.91	2.27	3.55	3.41	3.55	3.69	3.84	4.00	4.16	4.33

Summation of Flows Below Newtown at Head (DC131)
(Including Newtown Canal, Lester Canal, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Newtown Canal at Head (DC131)	11.77	12.43	11.77	12.59	13.31	14.11	15.00	16.00	17.12	18.46	14.48	15.49	16.37	17.36	18.45	19.68	21.06	22.71
Newtown 1 (b/w Head and Newtown Reservoir)			2.16	3.50	3.64	3.79	3.94	4.10	4.27	4.44	2.66	4.31	4.48	4.66	4.85	5.04	5.25	5.46
Newtown Canal d/s of Reservoir (DC130)	9.61	8.97	9.61	9.10	9.67	10.32	11.06	11.90	12.85	14.02	12.01	11.38	12.09	12.90	13.83	14.88	16.06	17.53
Lester Canal at Head (DC153)	1.20	1.35	1.20	1.37	1.42	1.48	1.54	1.60	1.67	1.74	1.46	1.67	1.73	1.81	1.88	1.95	2.04	2.12
Newtown Canal II (b/w Newtown Reservoir and DC164)			3.98	3.29	3.42	3.56	3.71	3.86	4.01	4.18	4.98	4.11	4.28	4.45	4.64	4.83	5.01	5.23
Delivery to Lake Wildwood WTP			2.87	2.94	3.26	3.65	4.12	4.68	5.33	6.20	7.18	7.35	8.15	9.13	10.30	11.70	13.33	15.50
Newtown Canal III at Prophets (DC164)	1.56	1.49	1.56	1.50	1.56	1.63	1.69	1.76	1.83	1.91	3.54	3.41	3.54	3.70	3.84	4.00	4.15	4.34

Summary of RWMP Estimated Flows for the DS Canal System (in cfs)

Schematic: D3

Calibration Year: 2007

DS System Estimated Flows
(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
	3.51	0.54	0.15	0.20	0.18	0.03	0.03	0.03	0.03	0.03	0.03	0.04	1.34	0.25	0.04	0.04	0.04	0.04	0.04	0.05	0.05
DS 2	3.51	0.54	0.12	0.55	2.39	0.37	0.38	0.40	0.42	0.43	0.45	0.47	1.36	3.24	0.50	0.52	0.54	0.56	0.59	0.61	0.64
DS 3	3.51	0.54	0.60	0.75	2.55	0.39	0.41	0.43	0.43	0.43	0.43	0.43	1.36	3.45	0.53	0.55	0.58	0.58	0.58	0.58	0.58
DS 4	2.26	1.87	0.30	0.75	0.36	0.30	0.31	0.31	0.31	0.31	0.31	0.31	1.36	0.48	0.40	0.42	0.42	0.42	0.42	0.42	0.42
DS Ext.	0.00	0.00	0.42	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red Dog	2.04	2.26	0.68	0.75	0.22	0.25	0.26	0.26	0.26	0.26	0.26	0.26	1.14	0.25	0.28	0.29	0.29	0.29	0.29	0.29	0.29

Summation of Flows Below DS at Head (DC145)
(Including DS & Lower Grass Valley Canals, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
DS Canal at Head (DC145)	55.53	55.06	56.11	49.28	53.25	56.37	59.67	63.16	66.87	70.81	75.19	66.04	71.36	75.54	79.96	84.63	89.61	94.89
Delivery to Nevada City Treatment Plant			0.72	0.74	0.87	1.01	1.18	1.38	1.61	1.88	1.80	1.85	2.18	2.53	2.95	3.45	4.03	4.70
DS 1			0.18	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.24	0.04	0.04	0.04	0.04	0.04	0.04	0.05
Red Dog Canal at Head (DC149)	0.22	0.24	0.22	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.29	0.30	0.30	0.30	0.30	0.30	0.30
DS Canal below Red Dog Road			55.00	48.27	52.09	55.08	58.20	61.50	64.97	68.65	73.70	64.68	69.80	73.81	77.99	82.41	87.06	91.99
DS 2			2.39	0.37	0.38	0.40	0.42	0.43	0.45	0.47	3.25	0.50	0.52	0.54	0.57	0.58	0.61	0.64
DS Canal below DS Pumps to E. George WTP			52.60	47.90	51.71	54.68	57.78	61.06	64.52	68.18	71.54	65.14	70.33	74.36	78.58	83.04	87.75	92.72
DS 3			2.55	0.39	0.41	0.43	0.43	0.43	0.43	0.43	3.47	0.53	0.56	0.58	0.58	0.58	0.58	0.58
Lower Grass Valley at Head (DC148) - Linked Lower Grass Valley Results	10.39	10.63	10.81	10.99	12.62	13.33	14.11	14.96	15.90	16.93	13.62	13.85	15.90	16.80	17.78	18.85	20.03	21.33
DS Canal at Town Talk (DC146)	39.80	39.14	39.24	36.52	38.68	40.92	43.25	45.67	48.20	50.82	53.37	49.67	52.60	55.65	58.82	62.11	65.55	69.12
DS 4			0.36	0.30	0.31	0.31	0.31	0.31	0.31	0.31	0.49	0.41	0.42	0.42	0.42	0.42	0.42	0.42
Wolf Creek Release (Spill to Tarr Canal)			35.18	36.22	38.37	40.61	42.94	45.36	47.89	50.51	47.84	49.26	52.18	55.23	58.40	61.69	65.13	68.69
DS Canal Extension below Wolf Creek Spill			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DS Pump to Chicago Park			3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Summary of RWMP Estimated Flows for the Lower Grass Valley System (below DC148) (in cfs)

Schematic: D4

Calibration Year: 2007

Lower Grass Valley Estimated Flows

(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Allison Ranch 1	0.06	0.06	1.00	1.19	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.23	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Allison Ranch 2	1.03	1.07	0.14	0.33	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.35	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Allison Ranch 3	1.03	1.07	0.61	0.80	1.53	1.60	1.67	1.67	1.67	1.67	1.67	1.67	2.27	3.47	3.64	3.78	3.78	3.78	3.78	3.78	3.78
Corey	1.55	1.42	0.26	0.60	1.58	1.46	1.55	1.65	1.75	1.86	1.97	2.09	1.17	1.86	1.72	1.82	1.94	2.05	2.18	2.31	2.46
Lafayette	1.03	1.07	0.46	0.68	0.45	0.47	0.49	0.51	0.53	0.55	0.58	0.60	2.27	1.02	1.07	1.11	1.16	1.21	1.25	1.31	1.36
Lower Grass Valley	3.90	3.29	0.63	0.80	1.57	1.34	1.39	1.39	1.39	1.39	1.39	1.39	1.26	1.99	1.69	1.76	1.76	1.76	1.76	1.76	1.76
Rough & Ready 1	1.67	1.62	0.24	0.75	1.99	2.12	3.10	3.23	3.36	3.50	3.64	3.79	1.27	2.53	2.70	3.95	4.11	4.28	4.45	4.63	4.82
Rough & Ready 2	1.70	1.87	0.52	0.85	1.06	1.19	1.28	1.39	1.50	1.63	1.76	1.91	1.43	1.51	1.69	1.83	1.98	2.15	2.33	2.52	2.72

Summation of Flows Below DC148

(Including Lower Grass Valley, Allison Ranch, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Lower Grass Valley at head (DC148)	10.39	10.63	10.81	10.99	12.62	13.33	14.11	14.96	15.90	16.93	13.62	13.85	15.90	16.80	17.78	18.85	20.03	21.33
Lower Grass Valley			1.57	1.34	1.39	1.39	1.39	1.39	1.39	1.39	1.98	1.69	1.75	1.75	1.75	1.75	1.75	1.75
Delivery to City of Grass Valley WTP (DC147)	2.40	2.51	2.40	2.47	2.80	3.16	3.57	4.03	4.56	5.15	3.46	3.56	4.03	4.55	5.14	5.80	6.57	7.42
Allison Ranch Canal at Head (DC158)	6.42	6.79	6.84	7.17	8.43	8.78	9.15	9.54	9.95	10.39	8.41	8.82	10.37	10.80	11.25	11.73	12.24	12.78
Allison Ranch 1 (d/s of Alta Hill Reservoir to Rough & Ready Split)			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Rough and Ready Canal at Head (DC152)	3.05	3.09	3.05	3.31	4.39	4.62	4.86	5.13	5.40	5.69	3.87	4.20	5.58	5.87	6.17	6.52	6.86	7.23
Rough & Ready I (u/s of Rough & Ready Reservoir)			1.99	2.12	3.10	3.23	3.36	3.50	3.64	3.79	2.53	2.69	3.94	4.10	4.27	4.45	4.62	4.81
Rough & Ready II (At Reservoir Release DC155)	1.06	1.16	1.06	1.19	1.28	1.39	1.50	1.63	1.76	1.91	1.52	1.70	1.83	1.99	2.15	2.33	2.52	2.73
Allison Ranch canal d/s of R&R split and CCC Reservoir (DC219)	3.79	3.81	3.79	3.86	4.03	4.15	4.27	4.40	4.54	4.68	5.12	5.21	5.44	5.60	5.76	5.94	6.13	6.32
Allison Ranch II			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Allison Ranch Canal d/s of CCC Reservoir (DC219)			3.78	3.85	4.02	4.14	4.26	4.39	4.52	4.67	5.10	5.20	5.43	5.59	5.75	5.93	6.10	6.30
Allison Ranch Canal at Fairgrounds			2.19	2.38	2.47	2.49	2.51	2.53	2.55	2.58	2.96	3.21	3.33	3.36	3.39	3.42	3.44	3.48
Allison Ranch III			1.53	1.60	1.67	1.67	1.67	1.67	1.67	1.67	3.47	3.63	3.79	3.79	3.79	3.79	3.79	3.79
Lafeyette Canal			0.45	0.47	0.49	0.51	0.53	0.55	0.58	0.60	1.02	1.07	1.11	1.16	1.20	1.25	1.32	1.36
Spill to Wolf Creek (DC165)	0.21	0.31	0.21	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.45	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Corey Canal at Head (DC207)	1.58	1.44	1.58	1.46	1.55	1.65	1.75	1.86	1.97	2.09	1.85	1.71	1.81	1.93	2.05	2.18	2.30	2.45

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Summary of RWMP Estimated Flows for the Tarr & B Canal System (in cfs)

Schematic: D5

Calibration Year: 2007

Tarr & B System Estimated Flows

(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
B, Miller, & Upper Wolf	0.72	0.66	0.68	0.80	4.63	4.28	4.46	4.64	4.83	5.02	5.02	5.02	1.20	5.58	5.16	5.37	5.59	5.82	6.05	6.05	6.05
Bald Hill	0.44	0.40	0.94	0.94	1.39	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.39	1.93	1.78	1.78	1.78	1.78	1.78	1.78	1.78
Beyers	0.87	0.81	0.33	0.42	2.05	1.92	1.99	2.07	2.16	2.25	2.34	2.43	1.22	2.49	2.33	2.42	2.52	2.63	2.73	2.84	2.96
Carpenter	1.49	1.53	0.40	0.51	1.64	1.69	1.76	1.83	1.91	1.98	2.06	2.15	1.14	1.87	1.93	2.01	2.09	2.18	2.26	2.36	2.45
Casey Loney & Stinson Pipe	2.43	2.12	0.29	0.54	0.86	0.75	0.76	0.78	0.80	0.81	0.83	0.84	1.38	1.18	1.04	1.06	1.08	1.10	1.12	1.15	1.17
Clear Creek	0.87	0.81	0.46	0.59	3.74	3.50	3.64	3.79	3.94	4.10	4.27	4.44	1.22	4.55	4.26	4.43	4.61	4.80	4.99	5.20	5.41
Cole	3.34	3.52	0.31	0.39	3.17	3.38	3.51	3.66	3.80	3.96	4.12	4.29	1.65	5.25	5.59	5.81	6.05	6.30	6.55	6.82	7.09
Cole Viet	1.64	1.55	0.32	0.74	2.38	2.32	2.42	2.51	2.62	2.72	2.83	2.95	1.23	2.92	2.85	2.96	3.08	3.21	3.34	3.47	3.62
Lower Wolf	2.39	2.30	0.71	0.81	2.14	2.08	2.17	2.25	2.34	2.34	2.34	2.34	1.20	2.56	2.49	2.59	2.70	2.81	2.81	2.81	2.81
Pearl Barnes	2.02	2.02	0.45	0.60	0.77	0.78	0.81	0.84	0.88	0.91	0.95	0.99	1.22	0.94	0.94	0.98	1.02	1.06	1.11	1.15	1.20
Pet Hill 1	0.91	0.90	0.49	0.65	1.56	1.57	1.63	1.70	1.76	1.84	1.91	1.99	1.37	2.14	2.15	2.23	2.33	2.42	2.52	2.62	2.73
Pet Hill 2	0.91	0.90	0.30	0.38	0.40	0.40	0.41	0.43	0.45	0.47	0.49	0.51	1.37	0.55	0.55	0.57	0.59	0.62	0.64	0.67	0.69
Pet Hill Ext.	0.91	0.90	0.33	0.45	0.22	0.22	0.22	0.23	0.23	0.24	0.24	0.25	1.37	0.30	0.30	0.31	0.31	0.32	0.33	0.33	0.34
Smith Gordon	1.03	1.08	0.45	0.62	3.50	3.70	3.85	4.01	4.17	4.34	4.52	4.70	1.22	4.28	4.54	4.72	4.91	5.11	5.32	5.53	5.76
Tarr 1	1.57	1.01	0.30	0.34	3.03	1.96	2.00	2.04	2.08	2.12	2.17	2.21	1.18	3.59	2.32	2.37	2.42	2.47	2.52	2.57	2.62
Tarr 2 & Breckenridge	1.59	1.67	0.45	0.51	8.48	8.99	9.17	9.35	9.54	9.73	9.93	10.13	1.22	10.37	11.00	11.22	11.44	11.67	11.91	12.15	12.39
Tarr 3	0.27	0.26	0.57	0.65	1.20	1.15	1.17	1.19	1.22	1.24	1.27	1.29	1.68	2.02	1.92	1.96	2.00	2.04	2.08	2.12	2.17
Tarr 4	0.29	0.31	0.82	0.82	5.27	5.76	5.76	5.76	5.76	5.76	5.76	5.76	1.40	7.38	8.08	8.08	8.08	8.08	8.08	8.08	8.08

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Summation of Flows Below Tarr at Head (DC169)

(Including Snow Mountain Canal, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Tarr Canal at Head (DC169)	46.41	45.49	46.41	45.71	47.02	48.37	49.77	51.12	52.32	53.57	54.76	53.94	55.48	57.08	58.73	60.32	61.74	63.21
Tarr 1 Canal			3.03	1.96	2.00	2.04	2.08	2.12	2.17	2.21	3.58	2.31	2.36	2.41	2.45	2.50	2.56	2.61
B Canal at Head (DC142)	14.73	14.48	14.73	14.53	15.12	15.74	16.37	16.94	17.33	17.74	17.68	17.44	18.14	18.89	19.64	20.33	20.80	21.29
B & Miller Canals			4.63	4.28	4.46	4.64	4.83	5.02	5.02	5.02	5.56	5.14	5.35	5.57	5.80	6.02	6.02	6.02
Cole Viet Canal at Head (DC144)	2.38	2.39	2.38	2.32	2.42	2.51	2.62	2.72	2.83	2.95	2.93	2.85	2.98	3.09	3.22	3.35	3.48	3.63
Cole Canal at Head (DC143)	3.17	3.34	3.17	3.38	3.51	3.66	3.80	3.96	4.12	4.29	5.23	5.58	5.79	6.04	6.27	6.53	6.80	7.08
Wolf Canal			4.55	4.55	4.73	4.93	5.13	5.24	5.36	5.48	5.46	5.46	5.68	5.92	6.16	6.29	6.43	6.58
Pearl Barnes Canal at Head (DC212)	0.77	0.77	0.77	0.78	0.81	0.84	0.88	0.91	0.95	0.99	0.94	0.95	0.99	1.02	1.07	1.11	1.16	1.21
Wolf Canal at Wolf Road (DC211)	3.78	3.73	3.78	3.77	3.92	4.08	4.25	4.33	4.41	4.49	4.54	4.52	4.70	4.90	5.10	5.20	5.29	5.39
Carpenter Canal at Head (DC213)	1.64	1.67	1.64	1.69	1.76	1.83	1.91	1.98	2.06	2.15	1.87	1.93	2.01	2.09	2.18	2.26	2.35	2.45
Lower Wolf Canal (d/s of Carpenter Canal)			2.14	2.08	2.17	2.25	2.34	2.34	2.34	2.34	2.57	2.50	2.60	2.70	2.81	2.81	2.81	2.81
Tarr Canal at Hog Chute (DC156)	28.65	29.06	28.65	29.22	29.89	30.59	31.31	32.06	32.83	33.62	34.95	35.65	36.47	37.32	38.20	39.11	40.05	41.02
Tarr 2 (including Breckinridge) d/s of B to the Tarr/Clear Creek Split			8.48	8.99	9.17	9.35	9.54	9.73	9.93	10.13	10.35	10.97	11.19	11.41	11.64	11.87	12.11	12.36
Clear Creek Lateral at Head (DC157)	5.79	5.36	5.79	5.41	5.63	5.86	6.10	6.35	6.61	6.88	7.06	6.60	6.87	7.15	7.44	7.75	8.06	8.39
Clear Creek Lateral			3.74	3.50	3.64	3.79	3.94	4.10	4.27	4.44	4.56	4.27	4.44	4.62	4.81	5.00	5.21	5.42
Beyers Canal			2.05	1.92	1.99	2.07	2.16	2.25	2.34	2.43	2.50	2.34	2.43	2.53	2.64	2.75	2.85	2.96
Smith-Gordon Canal at Head (DC159)	7.92	7.85	7.92	7.91	8.16	8.42	8.69	8.97	9.26	9.57	9.66	9.65	9.96	10.27	10.60	10.94	11.30	11.68
Smith Cordon Canal			3.50	3.70	3.85	4.01	4.17	4.34	4.52	4.70	4.27	4.51	4.70	4.89	5.09	5.29	5.51	5.73
Casey Loney Canal (& Stinson Pipe) at Head (DC188)	0.86	0.75	0.86	0.75	0.76	0.78	0.80	0.81	0.83	0.84	1.19	1.04	1.05	1.08	1.10	1.12	1.15	1.16
Bald Hill Canal at Head (DC161)	1.39	1.28	1.39	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.93	1.78	1.78	1.78	1.78	1.78	1.78	1.78
Pet Hill Canal at Head (DC160)	2.18	2.16	2.18	2.18	2.27	2.36	2.45	2.54	2.64	2.74	2.99	2.99	3.11	3.23	3.36	3.48	3.62	3.75
Pet Hill Extension			0.22	0.22	0.22	0.23	0.23	0.24	0.24	0.25	0.30	0.30	0.30	0.32	0.32	0.33	0.33	0.34
Pett Hill 1 Canal (b/w DC160 & HWY 20)			1.56	1.57	1.63	1.70	1.76	1.84	1.91	1.99	2.14	2.15	2.23	2.33	2.41	2.52	2.62	2.73
Pet Hill Canal Downstream of HWY 20			0.40	0.40	0.41	0.43	0.45	0.47	0.49	0.51	0.55	0.55	0.56	0.59	0.62	0.64	0.67	0.70
Tarr Canal d/s of Smith-Gordon Canal (DC162)	6.47	6.90	6.47	6.90	6.93	6.95	6.97	7.00	7.02	7.05	10.87	11.59	11.64	11.68	11.71	11.76	11.79	11.84
Tarr 3 Canal (b/w DC162 & DC201)			1.20	1.15	1.17	1.19	1.22	1.24	1.27	1.29	2.02	1.93	1.97	2.00	2.05	2.08	2.13	2.17
Tarr 4 Canal above Jauregius (DC201)	5.27	5.76	5.27	5.76	5.76	5.76	5.76	5.76	5.76	5.76	7.38	8.06	8.06	8.06	8.06	8.06	8.06	8.06

Summary of RWMP Estimated Flows for the Tunnel & China Union Canal System (in cfs)

Schematic: D6

Calibration Year: 2007

Tunnel & China Union Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
China Union 1	0.41	0.41	0.37	0.81	2.14	2.30	3.25	4.59	4.59	4.59	4.59	4.59	1.52	3.26	3.51	4.95	6.99	6.99	6.99	6.99	6.99
China Union 2	2.58	0.16	0.43	0.48	0.16	0.01	0.01	0.01	0.01	0.01	0.01	0.01	2.77	0.44	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Town & Ousley Bar	0.47	0.47	0.14	0.16	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	1.58	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18
Keystone	0.78	0.82	0.46	0.60	1.34	1.42	1.47	1.53	1.59	1.66	1.73	1.80	1.14	1.52	1.61	1.68	1.74	1.81	1.89	1.97	2.04
Meade	6.44	6.39	0.06	0.07	1.14	1.14	1.16	1.18	1.21	1.23	1.26	1.28	1.53	1.75	1.74	1.78	1.81	1.85	1.89	1.92	1.96
Portuguese	3.31	3.26	0.73	0.81	0.62	0.62	0.63	0.64	0.66	0.67	0.68	0.68	1.43	0.89	0.88	0.90	0.92	0.94	0.96	0.97	0.97
Quincy	1.47	1.42	1.00	1.00	1.83	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.16	2.13	2.07	2.07	2.07	2.07	2.07	2.07	2.07
Quincy Pipe	1.47	1.42	0.54	0.65	0.31	0.30	0.31	0.31	0.32	0.32	0.33	0.34	1.16	0.36	0.35	0.35	0.36	0.37	0.38	0.38	0.39
Rex 1	3.31	3.26	0.28	0.36	2.19	2.17	2.26	2.35	2.45	2.55	2.65	2.76	1.16	2.54	2.53	2.63	2.74	2.85	2.96	3.09	3.21
Rex 2	1.47	1.42	0.61	0.69	3.67	3.58	3.65	3.73	3.80	3.88	3.96	4.04	1.16	4.27	4.17	4.25	4.34	4.42	4.51	4.60	4.70
Riffle Box	1.84	2.27	0.43	0.54	3.68	4.56	4.65	4.75	4.84	4.94	5.04	5.14	1.30	4.78	5.92	6.04	6.16	6.28	6.41	6.54	6.67
Spenceville	0.73	0.70	0.48	0.54	2.90	2.79	2.85	2.91	2.96	3.02	3.08	3.15	1.29	3.73	3.59	3.66	3.73	3.81	3.89	3.97	4.05
Squirrel Creek	2.52	2.06	0.26	0.57	4.63	3.83	3.99	4.15	4.32	4.49	4.67	4.86	2.77	12.84	10.61	11.04	11.49	11.96	12.44	12.95	13.47
Tunnel	3.31	3.26	0.51	0.58	2.53	2.50	2.55	2.60	2.65	2.71	2.76	2.82	1.41	3.55	3.51	3.59	3.66	3.73	3.81	3.88	3.96
Tunnel Ext.	1.63	1.69	0.45	0.55	2.23	2.32	2.36	2.41	2.46	2.51	2.56	2.61	1.26	2.81	2.92	2.98	3.04	3.10	3.17	3.23	3.30
Farm	0.47	0.47	0.41	0.47	2.56	2.57	2.63	2.68	2.73	2.79	2.84	2.90	1.58	4.04	4.06	4.14	4.23	4.31	4.40	4.49	4.58

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Summation of Flows Below Tunnel at Head (DC140)

(Including Tunnel, China Union, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Tunnel System (DC140 + DC127 + DC183)	30.98	30.42	30.98	30.83	32.50	34.57	35.32	36.10	36.90	37.71	43.68	43.47	45.83	48.74	49.80	50.90	52.03	53.17
Keystone Canal at Head (DC127)	1.34	1.40	1.34	1.42	1.47	1.53	1.59	1.66	1.73	1.80	1.53	1.62	1.68	1.74	1.81	1.89	1.97	2.05
Tunnel Canal at Head (DC140)	20.64	20.37	20.64	20.50	21.03	21.56	22.12	22.69	23.28	23.87	29.10	28.91	29.65	30.40	31.19	31.99	32.82	33.66
Tunnel Canal			2.53	2.50	2.55	2.60	2.65	2.71	2.76	2.82	3.57	3.53	3.60	3.67	3.74	3.82	3.89	3.98
Riffle Box Canal at Head (DC136)	3.68	4.54	3.68	4.56	4.65	4.75	4.84	4.94	5.04	5.14	4.78	5.93	6.05	6.18	6.29	6.42	6.55	6.68
Tunnel Canal at Rex, Tunnel Ext & Squirrel Creek Split			14.43	13.44	13.82	14.21	14.62	15.04	15.48	15.91	20.35	18.95	19.49	20.04	20.61	21.21	21.83	22.43
Tunnel Release to Squirrel Creek (DC141)	4.63	3.79	4.63	3.83	3.99	4.15	4.32	4.49	4.67	4.86	12.83	10.61	11.05	11.50	11.97	12.44	12.94	13.46
Tunnel Extension at Head (DC178)	2.23	2.30	2.23	2.32	2.36	2.41	2.46	2.51	2.56	2.61	2.81	2.92	2.97	3.04	3.10	3.16	3.23	3.29
Rex Canal			7.57	7.29	7.47	7.66	7.85	8.04	8.24	8.44	10.67	10.28	10.53	10.80	11.07	11.34	11.62	11.90
Rex above Rex/Portuguese Split			1.75	1.63	1.73	1.84	1.94	2.06	2.17	2.28	2.47	2.30	2.44	2.59	2.74	2.90	3.06	3.21
Addition of Spill from Rough & Ready Reservoir (DC155)	1.06	1.16	-1.06	-1.16	-1.16	-1.16	-1.16	-1.16	-1.16	-1.16	-1.52	-1.66	-1.66	-1.66	-1.66	-1.66	-1.66	-1.66
Portuguese Canal			0.62	0.62	0.63	0.64	0.66	0.67	0.68	0.68	0.89	0.89	0.90	0.92	0.94	0.96	0.97	0.97
Rex 1 Canal (b/w Head and Reservoir)			2.19	2.17	2.26	2.35	2.45	2.55	2.65	2.76	2.54	2.52	2.62	2.73	2.84	2.96	3.07	3.20
Rex Canal at DC135 (Reservoir Outlet)	5.81	5.64	5.81	5.66	5.74	5.82	5.90	5.99	6.07	6.16	6.74	6.57	6.66	6.75	6.84	6.95	7.04	7.15
Rex 2 Canal (d/s of Rex Reservoir)			3.67	3.58	3.65	3.73	3.80	3.88	3.96	4.04	4.26	4.15	4.23	4.33	4.41	4.50	4.59	4.69
Quincy Canal & Pipe (diversion at Rex Canal)			2.14	2.08	2.09	2.09	2.10	2.11	2.11	2.12	2.48	2.41	2.42	2.42	2.44	2.45	2.45	2.46
Quincy Canal			1.83	1.78	1.78	1.78	1.78	1.78	1.78	1.78	2.12	2.06	2.06	2.06	2.06	2.06	2.06	2.06
Quincy Pipe			0.31	0.30	0.31	0.31	0.32	0.32	0.33	0.34	0.36	0.35	0.36	0.36	0.37	0.37	0.38	0.39
China Union at Head (DC183) less inflows via Squirrel Creek	9.00	8.64	9.00	8.92	10.00	11.47	11.61	11.75	11.89	12.04	13.68	13.56	15.20	17.43	17.65	17.86	18.07	18.30
China Union 1			2.14	2.30	3.25	4.59	4.59	4.59	4.59	4.59	3.25	3.50	4.94	6.98	6.98	6.98	6.98	6.98
China Union d/s of DC200 at Mooney Flat	2.82	2.62	2.82	2.69	2.74	2.80	2.85	2.91	2.97	3.03	7.81	7.45	7.59	7.76	7.89	8.06	8.23	8.39
Farm d/s of Union Reservoir			2.56	2.57	2.63	2.68	2.73	2.79	2.84	2.90	4.04	4.06	4.16	4.23	4.31	4.41	4.49	4.58
Town and Ousley Bar Canals d/s of Union Reservoir			0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.17
China Union 2			0.16	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.44	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Spenceville Canal at Head (DC176)	2.90	2.78	2.90	2.79	2.85	2.91	2.96	3.02	3.08	3.15	3.74	3.60	3.68	3.75	3.82	3.90	3.97	4.06
Meade Canal at Head (DC175)	1.14	1.13	1.14	1.14	1.16	1.18	1.21	1.23	1.26	1.28	1.74	1.74	1.77	1.81	1.85	1.88	1.93	1.96

Summary of RWMP Estimated Flows for the Chicago Park System Below Loma Rica Reservoir (in cfs)

Schematic: D7

Calibration Year: 2007

Chicago Park Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Meyer-Bierwagon Pipeline	1.15	1.15	0.09	0.34	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	1.22	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.06
Chicago Park 1	10.07	9.53	0.35	0.57	3.44	3.32	3.59	3.89	4.21	4.55	4.93	5.34	1.24	4.26	4.11	4.45	4.81	5.21	5.64	6.10	6.61
Chicago Park 2	1.87	1.44	0.43	0.68	0.96	0.75	0.81	0.88	0.95	1.03	1.11	1.21	1.21	1.16	0.91	0.98	1.06	1.15	1.24	1.35	1.46
Chicago Park 3	0.82	0.92	0.39	0.71	0.53	0.60	0.65	0.70	0.76	0.83	0.89	0.97	1.23	0.65	0.74	0.80	0.86	0.94	1.01	1.10	1.19
Chicago Park 4	1.21	1.20	0.54	0.80	1.32	1.33	1.44	1.56	1.69	1.83	1.83	1.83	1.25	1.64	1.66	1.80	1.95	2.11	2.28	2.28	2.28
Chicago Park East	1.36	1.37	0.39	0.80	1.44	1.47	1.60	1.73	1.87	2.02	2.19	2.37	1.27	1.82	1.87	2.02	2.19	2.37	2.57	2.78	3.01
Chicago Park West	1.23	1.25	0.45	0.78	1.95	2.02	2.19	2.37	2.56	2.78	3.00	3.25	1.22	2.37	2.47	2.67	2.89	3.13	3.39	3.66	3.97
John Henry Meyer	0.17	0.19	0.52	0.80	0.18	0.20	0.22	0.24	0.26	0.28	0.28	0.28	1.27	0.23	0.26	0.28	0.30	0.33	0.36	0.36	0.36
Little Greenhorn Creek	4.71	4.71	0.05	0.17	1.00	1.02	1.24	1.51	1.63	1.77	1.91	2.07	1.00	1.00	1.02	1.24	1.51	1.63	1.77	1.91	2.07
Meyer-Bierwagon Pipeline	1.21	1.20	0.71	0.85	0.35	0.35	0.38	0.41	0.41	0.41	0.41	0.41	1.25	0.43	0.44	0.48	0.51	0.51	0.51	0.51	0.51
O'Leary Pipeline	1.87	1.44	0.80	0.84	0.17	0.17	0.18	0.18	0.18	0.18	0.18	0.18	1.21	0.20	0.21	0.22	0.22	0.22	0.22	0.22	0.22
Ripkin	0.74	0.88	0.88	0.98	0.28	0.33	0.36	0.36	0.36	0.36	0.36	0.36	1.23	0.34	0.41	0.44	0.44	0.44	0.44	0.44	0.44
Ruess Pipeline	0.74	0.88	0.61	0.83	0.06	0.08	0.08	0.09	0.10	0.10	0.11	0.11	1.23	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.14
Smith Moulton Pipeline	1.15	1.15	0.90	0.98	0.34	0.35	0.38	0.38	0.38	0.38	0.38	0.38	1.22	0.42	0.42	0.46	0.46	0.46	0.46	0.46	0.46
Sontag	0.58	0.59	0.57	0.80	1.11	1.14	1.23	1.33	1.44	1.56	1.56	1.56	1.52	1.68	1.73	1.87	2.03	2.19	2.37	2.37	2.37
Sunshine Valley	1.18	1.05	0.40	0.64	1.99	1.80	1.95	2.11	2.29	2.47	2.68	2.90	1.26	2.51	2.27	2.46	2.66	2.88	3.12	3.37	3.65

Summation of Flows Below Loma Rica Reservoir

Including Chicago Park Canal, Rattlesnake Canal, Little Greenhorn Creek, and End Losses

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Chicago Park Canal at Head (DC105)	20.41	18.97	24.63	24.89	28.43	32.97	35.58	38.00	40.02	42.19	30.54	30.86	35.25	40.88	44.12	47.12	49.62	52.32
Little Greenhorn Creek			1.00	1.02	1.24	1.51	1.63	1.77	1.91	2.07	1.24	1.26	1.54	1.87	2.02	2.19	2.37	2.57
Chicago Park 1 (Between Loma Rica Reservoir and Head of Rattlesnake)			3.44	3.32	3.59	3.89	4.21	4.55	4.93	5.34	4.27	4.12	4.45	4.82	5.22	5.64	6.11	6.62
Rattlesnake Canal at Head (DC114)	9.22	9.19	9.51	9.92	12.09	15.20	16.45	17.40	18.14	18.93	12.08	12.60	15.35	19.30	20.89	22.10	23.04	24.04
Chicago Park d/s of DC192	11.12	10.80	10.68	10.63	11.51	12.38	13.29	14.28	15.04	15.86	12.92	12.86	13.93	14.98	16.08	17.28	18.20	19.19
Chicago Park 2 (Between Head of Rattlesnake and Head of Sunshine Valley)			0.96	0.75	0.81	0.88	0.95	1.03	1.11	1.21	1.16	0.91	0.98	1.06	1.15	1.25	1.34	1.46
O'Leary Pipeline			0.17	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22
Sunshine Valley (DC209)	1.99	1.77	1.99	1.80	1.95	2.11	2.29	2.47	2.68	2.90	2.51	2.27	2.46	2.66	2.89	3.11	3.38	3.65
Chicago Park d/s of DC225	7.74	7.97	7.57	7.91	8.56	9.21	9.87	10.59	11.07	11.57	9.31	9.73	10.53	11.33	12.14	13.03	13.62	14.23
Chicago Park 3 (between Sunshine Valley and Reuss Reservoir)			0.53	0.60	0.65	0.70	0.76	0.83	0.89	0.97	0.65	0.74	0.80	0.86	0.93	1.02	1.09	1.19
Sontag Canal at Head (DC179)	0.62	0.54	1.11	1.14	1.23	1.33	1.44	1.56	1.56	1.56	1.69	1.73	1.87	2.02	2.19	2.37	2.37	2.37
Ripkin Canal (DC180)	0.29	0.28	0.28	0.33	0.36	0.36	0.36	0.36	0.36	0.36	0.34	0.41	0.44	0.44	0.44	0.44	0.44	0.44
Ruess Pipeline			0.06	0.08	0.08	0.09	0.10	0.10	0.11	0.11	0.07	0.10	0.10	0.11	0.12	0.12	0.14	0.14
Chicago Park d/s of DC217	5.58	5.65	5.60	5.76	6.24	6.72	7.21	7.74	8.14	8.57	7.00	7.20	7.80	8.40	9.01	9.68	10.18	10.71
Chicago Park 4 (Between Reuss Reservoir and Chicago Park E/W Split)			1.32	1.33	1.44	1.56	1.69	1.83	1.83	1.83	1.65	1.66	1.80	1.95	2.11	2.29	2.29	2.29
Meyers-Bierwagen Siphon			0.35	0.35	0.38	0.41	0.41	0.41	0.41	0.41	0.44	0.44	0.48	0.51	0.51	0.51	0.51	0.51
Chicago Park West at Head (DC187)	1.87	1.89	2.32	2.40	2.60	2.78	2.98	3.19	3.42	3.67	2.83	2.93	3.17	3.39	3.64	3.89	4.17	4.48
Chicago Park West			1.95	2.02	2.19	2.37	2.56	2.78	3.00	3.25	2.38	2.46	2.67	2.89	3.12	3.39	3.66	3.97
Blum			0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.06
Smith Moulton			0.34	0.35	0.38	0.38	0.38	0.38	0.38	0.38	0.41	0.43	0.46	0.46	0.46	0.46	0.46	0.46
Chicago Park East d/s of DC216	1.56	1.63	1.62	1.68	1.82	1.97	2.13	2.30	2.47	2.65	2.06	2.13	2.31	2.50	2.71	2.92	3.14	3.37
Chicago Park East (including DC218 End Spill to Rollins)			1.44	1.47	1.60	1.73	1.87	2.02	2.19	2.37	1.83	1.87	2.03	2.20	2.37	2.57	2.78	3.01
John Henry Meyer (DC196)	0.18	0.20	0.18	0.20	0.22	0.24	0.26	0.28	0.28	0.28	0.23	0.25	0.28	0.30	0.33	0.36	0.36	0.36

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Summary of RWMP Estimated Flows for the Rattlesnake Canal System (in cfs)

Schematic: D8

Calibration Year: 2007

Rattlesnake Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Cherry Creek	0.63	0.83	0.52	0.80	0.27	0.36	0.39	0.43	0.46	0.46	0.46	0.46	1.75	0.48	0.64	0.69	0.75	0.81	0.81	0.81	0.81
Forest Springs	0.92	0.86	0.49	0.80	1.24	1.21	1.31	1.42	1.53	1.66	1.66	1.66	1.27	1.58	1.54	1.66	1.80	1.95	2.11	2.11	2.11
Grove	0.63	0.83	0.16	0.67	1.49	2.23	3.76	6.18	6.69	7.24	7.84	8.49	1.75	2.60	3.90	6.58	10.81	11.70	12.67	13.71	14.84
Kyler	1.80	1.82	0.32	0.57	1.05	1.08	1.17	1.27	1.37	1.49	1.61	1.74	1.31	1.38	1.42	1.54	1.67	1.80	1.95	2.11	2.29
Lower Maben	0.36	0.39	0.20	0.80	0.30	0.33	0.36	0.39	0.42	0.45	0.45	0.45	1.31	0.39	0.43	0.47	0.51	0.55	0.59	0.59	0.59
Maben Pipe	1.36	1.49	0.46	0.80	0.30	0.33	0.36	0.39	0.42	0.45	0.45	0.45	2.08	0.61	0.68	0.74	0.80	0.87	0.94	0.94	0.94
Rattlesnake 1	0.25	0.09	0.45	0.65	0.26	0.10	0.10	0.11	0.12	0.13	0.14	0.15	1.17	0.30	0.11	0.12	0.13	0.14	0.15	0.17	0.18
Rattlesnake 2	1.92	1.77	0.54	0.80	1.75	1.65	1.78	1.93	2.09	2.09	2.09	2.09	1.17	2.05	1.93	2.09	2.26	2.45	2.45	2.45	2.45
Rattlesnake 3	1.92	1.77	0.49	0.95	0.72	0.68	0.73	0.79	0.86	0.86	0.86	0.86	1.33	0.96	0.90	0.97	1.05	1.14	1.14	1.14	1.14
Rattlesnake Above Cedar Crest Siphon	2.79	2.60	0.66	0.81	0.44	0.42	0.45	0.49	0.53	0.53	0.53	0.53	1.27	0.56	0.53	0.57	0.62	0.67	0.67	0.67	0.67
Upper Maben	1.92	1.77	0.49	0.80	0.79	0.74	0.80	0.87	0.94	0.94	0.94	0.94	1.33	1.05	0.99	1.07	1.16	1.25	1.25	1.25	1.25
Woodpecker	1.22	1.05	0.57	0.80	0.92	0.81	0.87	0.95	1.02	1.11	1.11	1.11	1.17	1.08	0.95	1.03	1.11	1.20	1.30	1.30	1.30

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Summation of Rattlesnake Canal Flows

(Including End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow	Calculated Average Flows							Calibration Year Peak Flow	Calculated Peak Flows						
			2007	2008	2012	2016	2020	2024	2028	2032	2007	2008	2012	2016	2020	2024	2028	2032
Rattlesnake Canal at Head (DC114)	9.22	9.19	9.51	9.92	12.09	15.20	16.45	17.40	18.14	18.93	12.08	12.60	15.35	19.30	20.89	22.10	23.04	24.04
Rattlesnake Above Cedar Crest Siphon			0.44	0.42	0.45	0.49	0.53	0.53	0.53	0.53	0.56	0.53	0.57	0.62	0.67	0.67	0.67	0.67
Rattlensnake d/s of DC115	8.78	8.78	9.07	9.51	11.64	14.71	15.92	16.88	17.61	18.40	11.16	11.70	14.32	18.09	19.58	20.76	21.66	22.63
Rattlesnake 1			0.26	0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.30	0.12	0.12	0.13	0.14	0.15	0.16	0.18
Woodpecker (DC120)	0.92	0.79	0.92	0.81	0.87	0.95	1.02	1.11	1.11	1.11	1.08	0.95	1.02	1.11	1.19	1.30	1.30	1.30
Forest Springs (DC107)	1.24	1.19	1.24	1.21	1.31	1.42	1.53	1.66	1.66	1.66	1.57	1.54	1.66	1.80	1.94	2.11	2.11	2.11
Rattlesnake d/s of DC113	6.36	6.70	6.65	7.40	9.36	12.24	13.25	13.98	14.70	15.48	8.84	9.84	12.45	16.28	17.62	18.59	19.55	20.59
Rattlesnake 2			1.75	1.65	1.78	1.93	2.09	2.09	2.09	2.09	2.33	2.19	2.37	2.57	2.78	2.78	2.78	2.78
Rattlesnake 3			0.72	0.68	0.73	0.79	0.86	0.86	0.86	0.86	0.96	0.90	0.97	1.05	1.14	1.14	1.14	1.14
Maben			2.43	2.48	2.69	2.91	3.15	3.33	3.45	3.59	3.23	3.30	3.58	3.87	4.19	4.43	4.59	4.77
Upper Maben			0.79	0.74	0.80	0.87	0.94	0.94	0.94	0.94	1.05	0.98	1.06	1.16	1.25	1.25	1.25	1.25
Kyler (DC111)	1.05	1.06	1.05	1.08	1.17	1.27	1.37	1.49	1.61	1.74	1.38	1.41	1.53	1.66	1.79	1.95	2.11	2.28
Lower Maben (d/s of DC112)	0.30	0.32	0.30	0.33	0.36	0.39	0.42	0.45	0.45	0.45	0.39	0.43	0.47	0.51	0.55	0.59	0.59	0.59
Maben-Ficket Pipeline			0.30	0.33	0.36	0.39	0.42	0.45	0.45	0.45	0.62	0.69	0.75	0.81	0.87	0.94	0.94	0.94
Grove at Head (DC109)	1.76	2.31	1.76	2.59	4.16	6.61	7.15	7.70	8.30	8.95	3.08	4.53	7.28	11.57	12.51	13.48	14.53	15.66
Grove			1.49	2.23	3.76	6.18	6.69	7.24	7.84	8.49	2.61	3.90	6.58	10.82	11.71	12.67	13.72	14.86
Cherry Creek			0.27	0.36	0.39	0.43	0.46	0.46	0.46	0.46	0.47	0.63	0.68	0.75	0.81	0.81	0.81	0.81

Summary of RWMP Estimated Flows for the Cascade System (in cfs)

Schematic: D9

Calibration Year: 2007

Cascade Estimated Flows

(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Cascade	0.29	3.09	0.33	0.35	4.04	6.07	6.20	6.32	6.45	6.58	6.71	6.85	1.27	5.12	7.69	7.85	8.01	8.17	8.33	8.50	8.67
Upper Grass Valley	0.29	3.09	1.00	1.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	1.27	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Summation of Flows at Cascade Canal at Head (DC102)

(Including Cascade Canal, Upper Grass Valley, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Cascade Canal at Head (DC102)	41.26	39.59	39.81	42.75	48.72	55.48	59.90	63.53	65.66	67.96	50.56	54.29	61.87	70.46	76.07	80.68	83.39	86.31
Cascade			4.04	6.07	6.20	6.32	6.45	6.58	6.71	6.85	5.13	7.71	7.87	8.03	8.19	8.36	8.52	8.70
Elizabeth George Water Treatment Plant			6.52	7.04	9.09	10.68	11.82	12.50	12.60	12.60	16.30	17.60	22.73	26.70	29.55	31.25	31.50	31.50
Loma Rica Water Treatment Plant			4.56	4.70	4.96	5.45	6.00	6.41	6.28	6.28	11.40	11.75	12.40	13.63	15.00	16.03	15.70	15.70
Upper Grass Valley			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Chicago Park at Head (DC105)	20.41	18.97	24.63	24.89	28.43	32.97	35.58	38.00	40.02	42.19	30.54	30.86	35.25	40.88	44.12	47.12	49.62	52.32

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Summary of RWMP Estimated Flows Kemper East, Kemper West, Bean Culler Canal (in cfs)

Schematic: B1

Calibration Year: 2007

Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Edgewood	2.31	2.62	0.73	0.76	1.08	1.23	1.25	1.28	1.28	1.28	1.28	1.28	1.22	1.31	1.50	1.53	1.56	1.56	1.56	1.56	1.56
Kemper East, Kemper West & Bean Cullers	1.57	1.80	0.67	0.75	1.97	2.28	2.33	2.38	2.43	2.47	2.52	2.58	1.48	2.92	3.38	3.45	3.52	3.59	3.67	3.74	3.82

Summation of Flows at Kemper at Atwood (BR362) (Including Kemper, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Total Delivery from Fiddler Green (PYB064 + BR108)	17.62	10.93	10.48	10.95	11.02	11.09	11.14	11.19	11.24	11.29	19.91	20.81	20.94	21.07	21.17	21.26	21.36	21.45
Kemper East, West, Bean Culler's Canal (BR362)	1.97	2.27	1.97	2.28	2.33	2.38	2.43	2.47	2.52	2.58	2.92	3.37	3.45	3.52	3.60	3.66	3.73	3.82
Edgewood at Head (BR108)	1.08	1.22	1.08	1.23	1.25	1.28	1.28	1.28	1.28	1.28	1.32	1.50	1.53	1.56	1.56	1.56	1.56	1.56
Delivery to Combie Ophir System via Ophir Pipe (PYB64 - BR362)	14.57	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14

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Schematic: B2

Summary of RWMP Estimated Flows for the Camp Far West System (in cfs)

Calibration Year: 2007

Camp Far West Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Bogdanoff	1.44	1.34	0.42	0.62	2.00	1.95	2.07	2.21	2.35	2.51	2.67	2.85	1.21	2.42	2.35	2.51	2.67	2.85	3.03	3.23	3.45
Camp Far West 1	1.43	1.39	0.44	0.65	7.63	7.58	8.07	8.60	9.17	9.77	10.41	11.09	1.28	9.78	9.71	10.35	11.02	11.75	12.52	13.34	14.21
Camp Far West 2	1.43	1.39	0.35	0.52	1.54	1.53	1.62	1.73	1.85	1.97	2.09	2.23	1.28	1.97	1.95	2.08	2.22	2.36	2.52	2.68	2.86
Camp Far West 3	1.43	1.39	0.84	0.84	1.69	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.28	2.17	2.12	2.12	2.12	2.12	2.12	2.12	2.12
Camp Far West 4 & Ext. (d/s of Bogdanoff & Lateral 1 split)	0.18	0.20	0.58	0.76	0.87	0.98	1.04	1.11	1.18	1.26	1.26	1.26	1.28	1.11	1.25	1.33	1.42	1.51	1.61	1.61	1.61
Church Lateral	2.27	5.11	0.22	0.32	0.34	0.77	0.82	0.87	0.93	0.99	1.05	1.12	1.26	0.42	0.97	1.03	1.10	1.17	1.25	1.33	1.42
Forbes	1.76	2.05	0.54	0.76	1.32	1.56	1.66	1.77	1.89	2.01	2.14	2.14	1.25	1.65	1.95	2.07	2.21	2.36	2.51	2.67	2.67
Lateral 1 South	0.92	0.99	0.44	0.65	1.22	1.34	1.43	1.52	1.62	1.73	1.84	1.96	1.19	1.45	1.59	1.70	1.81	1.93	2.05	2.19	2.33
Lateral 2 South	1.43	1.39	0.76	0.76	0.47	0.46	0.46	0.46	0.46	0.46	0.46	0.46	1.19	0.56	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Lateral 4 South	1.64	1.74	0.80	0.80	1.62	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.21	1.95	2.07	2.07	2.07	2.07	2.07	2.07	2.07
Lateral 5 South	2.50	2.79	0.98	0.98	0.67	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.08	0.72	0.81	0.81	0.81	0.81	0.81	0.81	0.81
Renken	1.43	1.39	0.59	0.77	0.78	0.78	0.83	0.88	0.94	1.00	1.00	1.00	1.25	0.98	0.97	1.03	1.10	1.17	1.25	1.25	1.25
Wiswell-Gladding	0.92	0.99	0.55	0.76	2.55	2.79	2.98	3.17	3.38	3.60	3.84	3.84	1.19	3.03	3.32	3.54	3.77	4.02	4.28	4.56	4.56
Coon Creek Natural	4.17	2.55	0.44	0.65	8.13	5.05	5.39	5.74	6.11	6.52	6.94	7.40	1.94	15.75	9.79	10.43	11.11	11.84	12.62	13.44	14.32

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Summation of Flows Below Camp Far West at Head (BR334)

hurch, Forbes, Renken, Private Lateral, Lats 1-5, Bogdanoff, and Wiswell-Gladding Canal

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Camp Far West at Head (BR334)	34.94	32.99	35.22	33.47	35.94	38.70	41.13	43.49	45.85	47.99	45.08	42.84	46.00	49.54	52.65	55.67	58.69	61.43
Camp Far West 1 (b/w Head of CFW and Church's Spill to Coon Creek)			7.63	7.58	8.07	8.60	9.17	9.77	10.41	11.09	9.77	9.70	10.33	11.01	11.74	12.51	13.32	14.20
Coon Creek d/s of Church's Spill (BR336)	8.13	4.97	8.13	5.05	5.39	5.74	6.11	6.52	6.94	7.40	15.77	9.80	10.46	11.14	11.85	12.65	13.46	14.36
Camp Far West d/s of Church's Spill			19.46	20.84	22.48	24.36	25.85	27.20	28.50	29.50	24.91	26.68	28.77	31.18	33.09	34.82	36.48	37.76
Camp Far West 2 (d/s of Church's Spill BR336)			1.54	1.53	1.62	1.73	1.85	1.97	2.09	2.23	1.97	1.96	2.07	2.21	2.37	2.52	2.68	2.85
Lateral 5 South at Head (BR388)	0.67	0.75	0.67	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.72	0.81	0.81	0.81	0.81	0.81	0.81	0.81
Church Lateral at Head (BR360)	0.34	0.76	0.34	0.77	0.82	0.87	0.93	0.99	1.05	1.12	0.43	0.97	1.03	1.10	1.17	1.25	1.32	1.41
Camp Far West d/s of Church Lateral/Forbes Road			16.92	17.80	19.29	21.01	22.33	23.50	24.60	25.40	21.66	22.78	24.69	26.89	28.58	30.08	31.49	32.51
Camp Far West 3 (d/s of Church Lateral at Forbes Road)			1.69	1.65	1.65	1.65	1.65	1.65	1.65	1.65	2.72	2.66	2.66	2.66	2.66	2.66	2.66	2.66
Lateral 4 South at Head (BR353)	1.62	1.71	1.62	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.96	2.07	2.07	2.07	2.07	2.07	2.07	2.07
Forbes at Head (BR109)	1.32	1.54	1.32	1.56	1.66	1.77	1.89	2.01	2.14	2.14	1.65	1.95	2.08	2.21	2.36	2.51	2.68	2.68
Lateral 2 South			0.47	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Renken			0.78	0.78	0.83	0.88	0.94	1.00	1.00	1.00	0.98	0.98	1.04	1.10	1.18	1.25	1.25	1.25
Blackford Ranch Mutual Water Co. Delivery			0.42	0.53	1.07	1.77	2.00	2.00	2.00	2.00	0.54	0.68	1.37	2.27	2.56	2.56	2.56	2.56
Camp Far West & Extension (u/s of Bogdanoff & Lat 1 split)			10.62	11.11	11.91	12.76	13.68	14.66	15.64	16.43	13.59	14.22	15.24	16.33	17.51	18.76	20.02	21.03
Lateral 1 South at Head (BR346)	3.77	4.07	3.77	4.13	4.41	4.69	5.00	5.33	5.68	5.80	4.49	4.91	5.25	5.58	5.95	6.34	6.76	6.90
Lateral 1 South			1.22	1.34	1.43	1.52	1.62	1.73	1.84	1.96	1.45	1.59	1.70	1.81	1.93	2.06	2.19	2.33
Wiswell-Gladding			2.55	2.79	2.98	3.17	3.38	3.60	3.84	3.84	3.03	3.32	3.55	3.77	4.02	4.28	4.57	4.57
Bogdanoff at Head (BR347)	2.00	2.14	2.00	1.95	2.07	2.21	2.35	2.51	2.67	2.85	2.42	2.36	2.50	2.67	2.84	3.04	3.23	3.45
Camp Far West Extension (d/s of Bogdanoff & Lateral 1 split)			0.87	0.98	1.04	1.11	1.18	1.26	1.26	1.26	1.11	1.25	1.33	1.42	1.51	1.61	1.61	1.61
Delivery to Yankee Slough (BR335)	3.97	4.10	3.97	4.05	4.39	4.75	5.14	5.57	6.02	6.52	6.51	6.64	7.20	7.79	8.43	9.13	9.87	10.69

Summary of RWMP Estimated Flows for the Combie System below Combie Reservoir (in cfs)

Schematic: B3

Calibration Year: 2007

Combie System Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Combie Phase I	1.53	3.88	0.40	0.46	2.02	5.14	5.25	5.35	5.46	5.57	5.68	5.80	1.23	2.47	6.31	6.44	6.57	6.70	6.84	6.98	7.12
Combie Phase III	0.60	0.52	0.59	0.67	3.16	2.77	2.83	2.88	2.94	3.00	3.06	3.12	1.28	4.04	3.55	3.62	3.69	3.77	3.84	3.92	4.00
Hannaman I	0.51	0.43	0.53	0.60	4.43	3.76	3.84	3.91	3.99	4.07	4.16	4.24	1.25	5.56	4.72	4.82	4.91	5.01	5.11	5.22	5.32
Hannaman II	0.49	0.60	0.41	0.46	2.33	2.89	2.95	3.01	3.07	3.13	3.19	3.26	1.73	4.03	5.01	5.11	5.21	5.32	5.43	5.53	5.65
Magnolia I & Weeks	1.36	1.72	0.65	0.74	0.55	0.66	0.68	0.69	0.70	0.72	0.73	0.75	1.59	0.88	1.05	1.08	1.10	1.12	1.14	1.17	1.19
Magnolia II North	1.38	1.24	0.43	0.48	1.47	1.33	1.36	1.38	1.41	1.44	1.47	1.50	1.27	1.86	1.68	1.72	1.75	1.79	1.82	1.86	1.90
Magnolia II South	1.03	1.08	0.53	0.60	1.28	1.35	1.38	1.41	1.44	1.47	1.49	1.52	1.35	1.72	1.83	1.86	1.90	1.94	1.98	2.02	2.06
Magnolia 3 & LOTP WTP	0.35	0.23	0.46	0.51	4.26	4.05	4.13	4.21	4.29	4.38	4.47	4.56	1.44	6.16	5.85	5.96	6.08	6.21	6.33	6.46	6.59
Markwell	0.44	0.44	0.60	0.68	6.35	6.30	6.42	6.55	6.69	6.82	6.96	7.10	1.35	8.53	8.47	8.64	8.81	8.99	9.17	9.36	9.55
Sanford Struckman	0.81	0.83	0.59	0.67	4.64	4.81	4.91	5.01	5.11	5.21	5.32	5.43	1.17	5.44	5.65	5.77	5.88	6.00	6.12	6.25	6.37
Magnolia 3 Ext.	2.89	2.41	0.25	0.28	0.43	0.36	0.37	0.38	0.38	0.39	0.40	0.41	1.44	0.63	0.52	0.53	0.55	0.56	0.57	0.58	0.59
Combie Phase II	1.70	1.86	0.67	0.76	4.83	5.31	5.42	5.53	5.64	5.75	5.87	5.99	1.23	5.93	6.52	6.65	6.79	6.92	7.06	7.20	7.35

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Summation of Flows Below Combie Phase I at Head (BR301)

(Including Combie Phase I, II, III, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Combie Phase 1 at Head (BR301)	97.28	120.93	102.38	125.46	132.87	145.45	151.06	159.18	165.02	173.34	125.93	154.32	163.43	178.90	185.80	195.79	202.97	213.21
Combie Phase 1			2.02	5.14	5.25	5.35	5.46	5.57	5.68	5.80	2.48	6.32	6.46	6.58	6.72	6.85	6.99	7.13
Lincoln Treatment Plant (Online 2015)			0.00	0.00	0.00	5.00	5.00	7.50	7.50	10.00	0.00	0.00	0.00	12.50	12.50	18.75	18.75	25.00
Magnolia III at Head (BR311) including Magnolia III Ext and Lake of the Pines GC	7.96	7.35	7.96	7.74	10.10	12.49	12.90	13.34	13.81	14.32	11.46	11.15	14.54	17.99	18.58	19.21	19.89	20.62
Magnolia III Ext and Mutuals (BR310)	0.43	0.36	0.43	0.36	2.37	4.38	4.38	4.39	4.40	4.41	0.63	0.53	3.48	6.44	6.44	6.45	6.47	6.48
Magnolia III Ext.			0.43	0.36	0.37	0.38	0.38	0.39	0.40	0.41	0.63	0.53	0.54	0.56	0.56	0.57	0.59	0.60
Lake of the Pines Ranchos Mutual			0.00	0.00	2.00	4.00	4.00	4.00	4.00	4.00	0.00	0.00	2.94	5.88	5.88	5.88	5.88	5.88
Magnolia III			4.26	4.05	4.13	4.21	4.29	4.38	4.47	4.56	6.13	5.83	5.95	6.06	6.18	6.31	6.44	6.57
Lake of the Pines W.T.P. (BR354)	3.26	3.20	3.26	3.33	3.60	3.90	4.22	4.57	4.94	5.35	5.97	6.09	6.59	7.14	7.72	8.36	9.04	9.79
Combie Ophir I at Head (BR313) - Link from Combie Ophir I,II,III System	58.60	80.48	65.52	85.53	89.89	94.37	98.85	103.30	107.91	112.46	81.90	106.91	112.36	117.96	123.56	129.13	134.89	140.58
Combie Phase II at Head (BR303)	28.71	27.98	26.88	27.05	27.64	28.24	28.85	29.47	30.11	30.76	31.99	32.19	32.89	33.61	34.33	35.07	35.83	36.60
Magnolia I at Head (BR307) including the Weeks Canal	0.94	1.03	0.55	0.66	0.68	0.69	0.70	0.72	0.73	0.75	0.87	1.05	1.08	1.10	1.11	1.14	1.16	1.19
Combie Phase II Canal at Wolf Creek Siphon Inlet			26.33	26.39	26.96	27.55	28.15	28.76	29.38	30.01	32.65	32.72	33.43	34.16	34.91	35.66	36.43	37.21
Combie Phase II Canal			4.83	5.31	5.42	5.53	5.64	5.75	5.87	5.99	5.99	6.58	6.72	6.86	6.99	7.13	7.28	7.43
Magnolia II South at Head (BR309)	1.28	1.35	1.28	1.35	1.38	1.41	1.44	1.47	1.49	1.52	1.73	1.82	1.86	1.90	1.94	1.98	2.01	2.05
Magnolia II North at Head (BR308)	1.47	1.32	1.47	1.33	1.36	1.38	1.41	1.44	1.47	1.50	1.87	1.69	1.73	1.75	1.79	1.83	1.87	1.91
Combie Phase II, III above Wolf Canal (BR302)	20.20	19.00	18.76	18.39	18.81	19.23	19.66	20.10	20.55	21.00	23.26	22.80	23.32	23.85	24.38	24.92	25.48	26.04
Wolf Creek Return Water (addition into Combie System)			-2.14	-2.14	-2.14	-2.14	-2.14	-2.14	-2.14	-2.14	-2.65	-2.65	-2.65	-2.65	-2.65	-2.65	-2.65	-2.65
Hannaman 1 at Head (BR113)	6.76	6.62	6.76	6.65	6.79	6.92	7.06	7.20	7.35	7.50	7.44	7.32	7.47	7.61	7.77	7.92	8.09	8.25
Hannaman 1 (b/w BR113 and BR387)			4.43	3.76	3.84	3.91	3.99	4.07	4.16	4.24	4.87	4.14	4.22	4.30	4.39	4.48	4.58	4.66
Hannaman II at Head (BR387)	2.33	2.88	2.33	2.89	2.95	3.01	3.07	3.13	3.19	3.26	4.03	5.00	5.10	5.21	5.31	5.41	5.52	5.64
Combie Phase III at Head (BR304) d/s of Wolf Canal	14.14	13.81	14.14	13.88	14.16	14.45	14.74	15.03	15.34	15.65	18.10	17.77	18.12	18.50	18.87	19.24	19.64	20.03
Combie Phase III Canal			3.16	2.77	2.83	2.88	2.94	3.00	3.06	3.12	4.04	3.55	3.62	3.69	3.76	3.84	3.92	3.99
Sanford Struckman Canal at Head (BR389)	4.64	4.79	4.64	4.81	4.91	5.01	5.11	5.21	5.32	5.43	5.43	5.63	5.74	5.86	5.98	6.10	6.22	6.35
Markwell at Head (BR380)	6.35	6.27	6.35	6.30	6.42	6.55	6.69	6.82	6.96	7.10	8.57	8.51	8.67	8.84	9.03	9.21	9.40	9.59

To print the report press Ctrl and P or Right Click and scroll to "Print"

Summary of RWMP Estimated Flows for the Combie Ophir System (in cfs)

Schematic: B4

Calibration Year: 2007

Combie Ophir I Estimated Flows

(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Columbia East	1.81	1.76	0.45	0.56	0.68	0.67	0.71	0.75	0.79	0.83	0.87	0.92	1.17	0.80	0.79	0.83	0.87	0.92	0.97	1.02	1.07
Columbia West	0.75	1.11	0.68	0.75	0.32	0.49	0.51	0.54	0.57	0.60	0.63	0.63	1.17	0.38	0.57	0.60	0.63	0.67	0.70	0.74	0.74
Combie Ophir II	0.75	1.11	0.42	0.58	1.43	2.15	2.26	2.38	2.51	2.64	2.78	2.93	1.15	1.64	2.48	2.61	2.75	2.89	3.05	3.21	3.38
Combie Ophir III	0.75	1.11	0.41	0.55	0.26	0.40	0.42	0.44	0.46	0.49	0.52	0.54	1.25	0.33	0.50	0.53	0.55	0.58	0.61	0.65	0.68
Lone Star & Rainey	0.58	0.71	0.70	0.79	3.74	4.27	4.50	4.74	4.74	4.74	4.74	4.74	1.16	4.34	4.97	5.23	5.51	5.51	5.51	5.51	5.51
Pickett & Beck	0.97	0.80	0.50	0.69	1.97	1.79	1.88	1.98	2.09	2.20	2.31	2.44	1.25	2.46	2.23	2.34	2.47	2.60	2.74	2.88	3.03
Rudd	0.83	0.78	0.92	0.92	1.86	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.16	2.16	2.03	2.03	2.03	2.03	2.03	2.03	2.03
Willits & Oest	1.09	1.04	0.66	0.78	4.80	4.63	4.88	5.14	5.41	5.41	5.41	5.41	1.14	5.48	5.29	5.57	5.87	6.18	6.18	6.18	6.18

Summation of Flows Below Combie Ophir I at Head (BR313)

(Including Combie Ophir I, Orr/Coon Creek Release, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Combie Ophir I at Head (BR313)	58.60	80.48	65.52	85.53	89.89	94.37	98.85	103.30	107.91	112.46	81.90	106.91	112.36	117.96	123.56	129.13	134.89	140.58
Lone Star at Head (BR318) (including Rainey Canal)	5.59	5.90	5.59	6.02	6.25	6.49	6.49	6.49	6.49	6.49	6.48	6.98	7.25	7.53	7.53	7.53	7.53	7.53
Lone Star & Rainey Canals			3.74	4.27	4.50	4.74	4.74	4.74	4.74	4.74	4.34	4.95	5.22	5.50	5.50	5.50	5.50	5.50
Rudd Canal (BR320)	1.86	1.75	1.86	1.75	1.75	1.75	1.75	1.75	1.75	1.75	2.16	2.03	2.03	2.03	2.03	2.03	2.03	2.03
Combie Ophir I d/s of Lone Star Canal			59.92	79.51	83.64	87.89	92.36	96.81	101.42	105.97	74.90	99.39	104.55	109.86	115.45	121.01	126.78	132.46
Oest at Head (BR331) (including Willits Canal)	4.80	4.57	4.80	4.63	4.88	5.14	5.41	5.41	5.41	5.41	5.47	5.28	5.56	5.86	6.17	6.17	6.17	6.17
Orr Creek Release (BR319)	14.69	30.11	14.69	34.87	37.15	39.59	42.19	44.95	47.90	51.04	22.62	53.70	57.21	60.97	64.97	69.22	73.77	78.60
Combie Ophir II at Head (BR332)	33.53	39.94	40.44	40.01	41.61	43.16	44.77	46.45	48.11	49.53	46.51	46.01	47.85	49.63	51.49	53.42	55.33	56.96
Combie Ophir II (b/w BR 332 to Rock Creek Siphon)			3.40	3.94	4.15	4.37	4.60	4.84	5.10	5.37	3.91	4.53	4.77	5.03	5.29	5.57	5.87	6.18
Combie Ophir II			1.43	2.15	2.26	2.38	2.51	2.64	2.78	2.93	1.64	2.47	2.60	2.74	2.89	3.04	3.20	3.37
North Auburn WTP (Not Included in flow at Combie Ophir I)			2.96	3.03	3.53	3.96	4.31	4.60	4.82	4.97	7.40	7.58	8.83	9.90	10.78	11.50	12.05	12.43
Pickett at Head (BR312) including Beck Canal	1.97	1.70	1.97	1.79	1.88	1.98	2.09	2.20	2.31	2.44	2.46	2.24	2.35	2.48	2.61	2.75	2.89	3.05
Combie Ophir III at Dry Creek Siphon Inlet			37.03	36.07	37.46	38.79	40.17	41.61	43.02	44.16	42.58	41.48	43.08	44.61	46.20	47.85	49.47	50.78
Combie Ophir III at Dry Creek Siphon			0.26	0.40	0.42	0.44	0.46	0.49	0.52	0.54	0.30	0.47	0.49	0.51	0.54	0.57	0.61	0.63
Columbia East at Head (BR117)	0.68	0.66	0.68	0.67	0.71	0.75	0.79	0.83	0.87	0.92	0.80	0.78	0.83	0.88	0.92	0.97	1.02	1.08
Columbia West			0.32	0.49	0.51	0.54	0.57	0.60	0.63	0.63	0.37	0.57	0.60	0.63	0.67	0.70	0.74	0.74
Deadmans Ravine at Head (BR352) - Linked Valley View Gold Hill System	15.45	14.74	15.48	14.62	15.42	16.25	17.12	18.04	18.91	19.54	24.30	22.95	24.21	25.51	26.88	28.32	29.69	30.68
PG&E Delivery (via Ophir Pipe) Addition - Linked to PG&E System			-7.44	-7.44	-7.44	-7.44	-7.44	-7.44	-7.44	-7.44	-14.14	-14.14	-14.14	-14.14	-14.14	-14.14	-14.14	-14.14
Combie Ophir IV at Head (BR351) - Linked to Combie Ophir IV System	27.72	27.04	27.72	27.33	27.84	28.25	28.67	29.09	29.52	29.97	31.88	31.43	32.02	32.49	32.97	33.45	33.95	34.47

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Summary of RWMP Estimated Flows for the Combie Ophir IV System (in cfs)

Schematic: B5

Calibration Year: 2007

Combie Ophir IV Estimated Flows (Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Combie Ophir IV	1.86	1.96	0.61	0.69	2.82	2.98	3.04	3.10	3.16	3.23	3.29	3.36	1.15	3.23	3.42	3.48	3.55	3.63	3.70	3.77	3.85
Dudley	1.52	1.47	0.63	0.72	7.85	7.60	7.75	7.90	8.06	8.23	8.39	8.56	1.16	9.09	8.79	8.97	9.15	9.34	9.52	9.72	9.91
Gold Blossom	2.04	1.74	0.67	0.76	6.93	5.95	6.07	6.19	6.31	6.44	6.57	6.70	1.23	8.51	7.30	7.44	7.59	7.75	7.90	8.06	8.23
Little Ophir & Hymas	1.86	1.96	0.48	0.54	2.18	2.31	2.36	2.40	2.45	2.50	2.55	2.60	1.15	2.50	2.64	2.70	2.75	2.81	2.86	2.92	2.98
Vernon	1.37	1.47	0.73	0.75	5.14	5.55	5.67	5.67	5.67	5.67	5.67	5.67	1.18	6.08	6.56	6.69	6.69	6.69	6.69	6.69	6.69
Rohr Stanley Pipe	1.86	1.96	0.77	0.84	1.65	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.15	1.90	2.19	2.19	2.19	2.19	2.19	2.19	2.19
St. Patrick's	2.31	2.09	0.58	0.66	1.14	1.03	1.05	1.08	1.10	1.12	1.14	1.17	1.18	1.35	1.22	1.25	1.27	1.30	1.33	1.35	1.38

Summation of Flows at Combie Ophir IV at Head (BR351) *(Including Combie Ophir IV, Lateral Canals, and End Losses)*

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Combie Ophir IV at Head (BR351)	27.72	27.04	27.72	27.33	27.84	28.25	28.67	29.09	29.52	29.97	31.88	31.43	32.02	32.49	32.97	33.45	33.95	34.47
Vernon at Head (BR366)	5.14	5.53	5.14	5.55	5.67	5.67	5.67	5.67	5.67	5.67	6.07	6.55	6.69	6.69	6.69	6.69	6.69	6.69
Rohr Shanley Pipe			1.65	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.90	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Combie Ophir IV d/s of Rohr-Shanley Pipeline (at Atwood Road)			20.92	19.87	20.27	20.67	21.09	21.52	21.95	22.39	24.06	22.85	23.31	23.77	24.25	24.75	25.24	25.75
Combie Ophir IV (b/w BR351 and St. Patrick's/Little Ophir Split)			2.82	2.98	3.04	3.10	3.16	3.23	3.29	3.36	3.24	3.43	3.50	3.57	3.63	3.71	3.78	3.86
Dudley at Head (BR315)	7.85	7.56	7.85	7.60	7.75	7.90	8.06	8.23	8.39	8.56	9.11	8.82	8.99	9.16	9.35	9.55	9.73	9.93
Gold Blossom at Head (BR364)	6.93	5.92	6.93	5.95	6.07	6.19	6.31	6.44	6.57	6.70	8.52	7.32	7.47	7.61	7.76	7.92	8.08	8.24
Little Ophir (including Hymas Canal)			2.18	2.31	2.36	2.40	2.45	2.50	2.55	2.60	2.51	2.66	2.71	2.76	2.82	2.88	2.93	2.99
St. Patrick's at Head (BR365)	1.14	1.03	1.14	1.03	1.05	1.08	1.10	1.12	1.14	1.17	1.35	1.22	1.24	1.27	1.30	1.32	1.35	1.38

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Summary of RWMP Estimated Flows for the Combie Ophir IV System (in cfs)

Calibration Year: 2007

Combie Ophir IV Estimated Flows

(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Combie Ophir IV	1.86	1.96	0.61	0.69	2.82	2.98	3.04	3.10	3.16	3.23	3.29	3.36	1.15	3.23	3.42	3.48	3.55	3.63	3.70	3.77	3.85
Dudley	1.52	1.47	0.63	0.72	7.85	7.60	7.75	7.90	8.06	8.23	8.39	8.56	1.16	9.09	8.79	8.97	9.15	9.34	9.52	9.72	9.91
Gold Blossom	2.04	1.74	0.67	0.76	6.93	5.95	6.07	6.19	6.31	6.44	6.57	6.70	1.23	8.51	7.30	7.44	7.59	7.75	7.90	8.06	8.23
Little Ophir & Hymas	1.86	1.96	0.48	0.54	2.18	2.31	2.36	2.40	2.45	2.50	2.55	2.60	1.15	2.50	2.64	2.70	2.75	2.81	2.86	2.92	2.98
Vernon	1.37	1.47	0.73	0.75	5.14	5.55	5.67	5.67	5.67	5.67	5.67	5.67	1.18	6.08	6.56	6.69	6.69	6.69	6.69	6.69	6.69
Rohr Stanley Pipe	1.86	1.96	0.77	0.84	1.65	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.15	1.90	2.19	2.19	2.19	2.19	2.19	2.19	2.19
St. Patrick's	2.31	2.09	0.58	0.66	1.14	1.03	1.05	1.08	1.10	1.12	1.14	1.17	1.18	1.35	1.22	1.25	1.27	1.30	1.33	1.35	1.38

Summation of Flows at Combie Ophir IV at Head (BR351)

(Including Combie Ophir IV, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Combie Ophir IV at Head (BR351)	27.72	27.04	27.72	27.33	27.84	28.25	28.67	29.09	29.52	29.97	31.88	31.43	32.02	32.49	32.97	33.45	33.95	34.47
Vernon at Head (BR366)	5.14	5.53	5.14	5.55	5.67	5.67	5.67	5.67	5.67	5.67	6.07	6.55	6.69	6.69	6.69	6.69	6.69	6.69
Rohr Shanley Pipe			1.65	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.90	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Combie Ophir IV d/s of Rohr-Shanley Pipeline (at Atwood Road)			20.92	19.87	20.27	20.67	21.09	21.52	21.95	22.39	24.06	22.85	23.31	23.77	24.25	24.75	25.24	25.75
Combie Ophir IV (b/w BR351 and St. Patrick's/Little Ophir Split)			2.82	2.98	3.04	3.10	3.16	3.23	3.29	3.36	3.24	3.43	3.50	3.57	3.63	3.71	3.78	3.86
Dudley at Head (BR315)	7.85	7.56	7.85	7.60	7.75	7.90	8.06	8.23	8.39	8.56	9.11	8.82	8.99	9.16	9.35	9.55	9.73	9.93
Gold Blossom at Head (BR364)	6.93	5.92	6.93	5.95	6.07	6.19	6.31	6.44	6.57	6.70	8.52	7.32	7.47	7.61	7.76	7.92	8.08	8.24
Little Ophir (including Hymas Canal)			2.18	2.31	2.36	2.40	2.45	2.50	2.55	2.60	2.51	2.66	2.71	2.76	2.82	2.88	2.93	2.99
St. Patrick's at Head (BR365)	1.14	1.03	1.14	1.03	1.05	1.08	1.10	1.12	1.14	1.17	1.35	1.22	1.24	1.27	1.30	1.32	1.35	1.38

Summary of RWMP Estimated Flows for the Valley View & Gold Hill System (in cfs)

Schematic: B6

Calibration Year: 2007

Valley View & Gold Hill Estimated Flows

(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Deadman's Ravine	2.42	1.38	0.80	0.90	2.01	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.57	3.15	2.06	2.06	2.06	2.06	2.06	2.06	2.06
Files	1.22	1.24	0.87	0.87	0.69	0.70	0.70	0.70	0.70	0.70	0.70	0.70	1.22	0.84	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Gold Hill I	0.54	0.56	0.64	0.76	7.48	7.65	8.06	8.48	8.93	8.93	8.93	8.93	1.30	9.70	9.92	10.44	11.00	11.58	11.58	11.58	11.58
Kilaga Springs	0.58	0.63	0.63	0.78	1.09	1.20	1.26	1.33	1.40	1.47	1.47	1.47	1.23	1.35	1.47	1.55	1.63	1.72	1.81	1.81	1.81
Iron Canyon	1.59	2.09	0.36	0.49	0.95	1.26	1.33	1.40	1.47	1.55	1.63	1.72	1.17	1.11	1.48	1.56	1.64	1.73	1.82	1.92	2.02
Lower Gold Hil II	1.78	2.05	0.57	0.75	3.68	4.30	4.53	4.77	5.02	5.29	5.57	5.57	1.32	4.85	5.67	5.97	6.29	6.62	6.97	7.34	7.34
Nicklas	1.44	1.47	0.78	0.78	1.19	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.23	1.47	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Old Whiskey Diggins	0.58	0.58	0.76	0.76	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	1.32	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Reilli	0.75	0.72	0.45	0.63	1.05	1.02	1.07	1.13	1.19	1.25	1.32	1.39	1.15	1.21	1.17	1.24	1.30	1.37	1.44	1.52	1.60
Stringham	2.84	3.20	0.81	0.81	0.87	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.37	1.19	1.34	1.34	1.34	1.34	1.34	1.34	1.34
Valley View 1	0.16	0.19	0.84	0.84	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	1.26	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Valley View 2	0.16	0.19	0.62	0.78	0.15	0.18	0.19	0.20	0.21	0.22	0.22	0.22	1.26	0.19	0.22	0.24	0.25	0.26	0.28	0.28	0.28
Valley View 3	0.16	0.19	0.46	0.63	0.34	0.40	0.42	0.44	0.47	0.49	0.52	0.54	1.26	0.43	0.50	0.53	0.56	0.59	0.62	0.65	0.68
Whiskey Diggins	1.75	1.58	0.09	0.12	5.52	5.43	5.72	6.02	6.34	6.68	7.03	7.40	1.32	7.31	7.19	7.57	7.97	8.40	8.84	9.31	9.80
Livingston	2.78	2.20	0.80	0.80	4.37	3.46	3.46	3.46	3.46	3.46	3.46	3.46	1.17	5.13	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Thomas	1.59	2.09	0.51	0.70	0.76	1.00	1.06	1.11	1.17	1.23	1.30	1.37	1.17	0.89	1.18	1.24	1.31	1.38	1.45	1.53	1.61
Gold Hill II	2.42	1.38	0.71	0.75	0.33	0.19	0.20	0.21	0.21	0.21	0.21	0.21	1.57	0.52	0.30	0.31	0.33	0.33	0.33	0.33	0.33

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Summation of Flows at Deadman's Ravine at Head (BR362)

(Including Combie Ophir 1, Orr/Coon Creek Release, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Valley View & Gold Hill Systems (BR352 + BR368)	22.93	22.39	22.96	22.27	23.47	24.74	26.05	26.97	27.84	28.47	36.05	34.96	36.85	38.84	40.90	42.34	43.71	44.70
Deadman's Ravine at Head (BR352)	15.45	14.74	15.48	14.62	15.42	16.25	17.12	18.04	18.91	19.54	24.30	22.95	24.21	25.51	26.88	28.32	29.69	30.68
Deadman's Ravine			2.01	1.32	1.32	1.32	1.32	1.32	1.32	1.32	3.16	2.07	2.07	2.07	2.07	2.07	2.07	2.07
Whiskey Diggins	5.52	5.87	5.52	5.43	5.72	6.02	6.34	6.68	7.03	7.40	7.18	7.06	7.44	7.83	8.24	8.68	9.14	9.62
Gold Hill I Spill			-5.13	-5.13	-5.13	-5.13	-5.13	-5.13	-5.13	-5.13	-8.05	-8.05	-8.05	-8.05	-8.05	-8.05	-8.05	-8.05
Upper Gold Hill II			0.33	0.19	0.20	0.21	0.21	0.21	0.21	0.21	0.52	0.30	0.31	0.33	0.33	0.33	0.33	0.33
Gold Hill II at Deadman's Ravine Diversion			12.75	12.81	13.31	13.83	14.38	14.96	15.48	15.73	16.83	16.91	17.57	18.26	18.98	19.75	20.43	20.76
Lower Gold Hill II at BR327 to Sailor's Ravine	3.68	4.24	3.68	4.30	4.53	4.77	5.02	5.29	5.57	5.57	4.64	5.42	5.71	6.01	6.33	6.67	7.02	7.02
Valley View at Head (BR323)	9.04	8.51	9.07	8.51	8.78	9.06	9.36	9.67	9.91	10.16	11.43	10.72	11.06	11.42	11.79	12.18	12.49	12.80
Valley View 1			0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Livingston at Head (BR329)	7.13	6.71	7.13	6.75	6.92	7.11	7.30	7.50	7.72	7.94	8.34	7.90	8.10	8.32	8.54	8.78	9.03	9.29
Livingston			4.37	3.46	3.46	3.46	3.46	3.46	3.46	3.46	5.11	4.05	4.05	4.05	4.05	4.05	4.05	4.05
Iron Canyon			0.95	1.26	1.33	1.40	1.47	1.55	1.63	1.72	1.11	1.47	1.56	1.64	1.72	1.81	1.91	2.01
Thomas			0.76	1.00	1.06	1.11	1.17	1.23	1.30	1.37	0.87	1.15	1.22	1.28	1.35	1.41	1.50	1.58
Reilli at Head (BR358)	1.05	1.01	1.05	1.02	1.07	1.13	1.19	1.25	1.32	1.39	1.21	1.17	1.23	1.30	1.37	1.44	1.52	1.60
Addition of Whiskey Diggins at End (BR112)	-3.80	-4.32	-3.80	-4.32	-4.32	-4.32	-4.32	-4.32	-4.32	-4.32	-5.21	-5.92	-5.92	-5.92	-5.92	-5.92	-5.92	-5.92
Valley View d/s of Whiskey Diggins			5.71	6.04	6.13	6.23	6.33	6.44	6.47	6.50	7.19	7.61	7.72	7.85	7.98	8.11	8.15	8.19
Old Whiskey Diggins			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Valley View 2			0.15	0.18	0.19	0.20	0.21	0.22	0.22	0.22	0.19	0.23	0.24	0.25	0.26	0.28	0.28	0.28
Stringham at Head (BR330)	0.87	0.98	0.87	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.19	1.34	1.34	1.34	1.34	1.34	1.34	1.34
Valley View d/s of Stringham			4.46	4.65	4.73	4.82	4.92	5.01	5.04	5.07	5.62	5.86	5.96	6.07	6.20	6.31	6.35	6.39
Valley View 3			0.34	0.40	0.42	0.44	0.47	0.49	0.52	0.54	0.43	0.50	0.53	0.55	0.59	0.62	0.66	0.68
Files at Head (BR118)	0.69	0.70	0.69	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.84	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Flow below V.V. Reservoir			3.42	3.55	3.61	3.68	3.75	3.82	3.82	3.82	4.21	4.37	4.44	4.53	4.61	4.70	4.70	4.70
Nicklas at Head (BR384)	1.19	1.22	1.19	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.46	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Kilaga Springs at Head (BR385)	1.09	1.18	1.09	1.20	1.26	1.33	1.40	1.47	1.47	1.47	1.34	1.48	1.55	1.64	1.72	1.81	1.81	1.81
Valley View Spill to Doty North (BR321) (linked)	1.13	1.26	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
Gold Hill I at Head d/s of Orr Creek Reservoir (BR368)	7.48	7.65	7.48	7.65	8.06	8.48	8.93	8.93	8.93	8.93	9.72	9.95	10.48	11.02	11.61	11.61	11.61	11.61

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Summary of RWMP Estimated Flows for the Auburn Ravine System (in cfs)

Schematic: B7

Calibration Year: 2007

Auburn Ravine Estimated Flows
(Individual Soft Service Boundaries)

Service Area	Calibration Year Flow Duty Acre-ft/Acre	Period Average Flow Duty Acre-ft/Acre	Current Saturation Levels (%) 2007	Estimated Saturation Levels (%) 2032	Calibration Year Average Flow 2007	Calculated Average Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032	Peak to Average Ratio	Calibration Year Peak Flow 2007	Calculated Peak Soft Service Area Demand 2008	2012	2016	2020	2024	2028	2032
Auburn Ravine I	1.73	1.37	0.34	0.55	2.20	1.77	1.92	2.08	2.25	2.43	2.64	2.85	1.27	2.79	2.25	2.44	2.64	2.86	3.09	3.35	3.63
Auburn Ravine II 1	2.28	2.14	0.51	0.78	4.77	4.58	4.96	5.37	5.81	6.29	6.81	6.81	1.20	5.71	5.48	5.93	6.42	6.95	7.52	8.14	8.14
Auburn Ravine II 2	2.28	2.14	0.50	0.76	5.85	5.61	6.07	6.57	7.11	7.70	8.34	8.34	1.20	7.00	6.71	7.27	7.87	8.51	9.22	9.98	9.98
Chevalier Pipeline	1.73	1.37	0.84	0.84	2.35	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.27	2.99	2.37	2.37	2.37	2.37	2.37	2.37	2.37
Clark-Jorstad	1.46	1.33	0.58	0.75	7.22	6.73	7.29	7.89	8.54	8.54	8.54	8.54	1.23	8.86	8.26	8.94	9.67	10.47	10.47	10.47	10.47
Comstock (u/s of BR116)	1.46	1.33	0.61	0.79	5.14	4.79	5.19	5.62	6.08	6.08	6.08	6.08	2.05	10.55	9.84	10.65	11.53	12.48	12.48	12.48	12.48
Doty North 1	1.46	1.33	0.42	0.70	1.89	1.76	1.91	2.06	2.23	2.42	2.62	2.83	1.23	2.32	2.16	2.34	2.53	2.74	2.97	3.21	3.48
Doty North 2	1.46	1.33	0.53	0.80	2.98	2.77	3.00	3.25	3.52	3.81	4.12	4.12	1.23	3.65	3.40	3.68	3.99	4.32	4.67	5.06	5.06
Doty South 2	1.49	1.47	0.68	0.75	7.19	7.27	7.87	7.87	7.87	7.87	7.87	7.87	1.61	11.60	11.73	12.70	12.70	12.70	12.70	12.70	12.70
Fruitvale & Markell	1.75	1.78	0.47	0.78	3.54	3.68	3.98	4.31	4.67	5.05	5.47	5.92	1.15	4.08	4.24	4.59	4.97	5.38	5.82	6.30	6.82
Hayt	2.77	2.67	0.58	0.75	4.41	4.34	4.70	5.08	5.50	5.50	5.50	5.50	1.16	5.09	5.01	5.43	5.88	6.36	6.36	6.36	6.36
Hemphill	2.39	1.17	0.23	0.37	8.82	7.94	8.59	9.30	10.06	10.89	11.79	12.76	1.41	12.46	11.21	12.14	13.14	14.22	15.39	16.66	18.03
Lincoln 1	2.63	2.38	0.35	0.57	2.04	1.88	2.04	2.21	2.39	2.59	2.80	3.03	1.16	2.38	2.19	2.37	2.57	2.78	3.01	3.25	3.52
Lincoln 2	2.63	2.38	0.25	0.42	2.12	1.96	2.12	2.29	2.48	2.69	2.91	3.15	1.16	2.47	2.27	2.46	2.66	2.88	3.12	3.38	3.66
Musser	2.28	2.14	0.53	0.80	2.71	2.60	2.81	3.05	3.30	3.57	3.86	3.86	1.20	3.24	3.11	3.37	3.65	3.95	4.27	4.62	4.62
Sohier-Ahart	2.28	2.14	0.57	0.80	2.40	2.30	2.49	2.70	2.92	3.16	3.16	3.16	1.20	2.87	2.76	2.99	3.23	3.50	3.79	3.79	3.79
Doty South 1	-9.84	-11.64	0.27	0.44	-0.72	-0.86	-0.93	-1.01	-1.09	-1.18	-1.28	-1.39	1.61	-1.15	-1.39	-1.51	-1.63	-1.77	-1.91	-2.07	-2.24
Comstock (d/s of BR116)	0.80	0.83	0.77	0.77	1.52	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.94	2.95	3.07	3.07	3.07	3.07	3.07	3.07	3.07

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Summation of Flows at Auburn Ravine I at Head (BR100)

(Including Auburn Ravine 1, Auburn Ravine II, Lateral Canals, and End Losses)

Canal Name	Calibration Year Average	Period Average 2003-2007	Calibration Year Average Flow 2007	Calculated Average Flows 2008	2012	2016	2020	2024	2028	2032	Calibration Year Peak Flow 2007	Calculated Peak Flows 2008	2012	2016	2020	2024	2028	2032
Auburn Ravine System (BR100 + BR220 + BR344)	65.15	59.77	65.30	61.45	66.32	70.95	75.96	79.72	83.53	85.75	82.93	78.04	84.23	90.11	96.47	101.24	106.08	108.90
Hemphill at Head (BR220)	8.82	7.26	8.82	7.94	8.59	9.30	10.06	10.89	11.79	12.76	12.44	11.20	12.11	13.11	14.18	15.35	16.62	17.99
Doty South at Head (BR344)	6.48	6.38	6.48	6.41	6.94	6.86	6.78	6.69	6.59	6.49	10.43	10.32	11.17	11.04	10.92	10.77	10.61	10.45
Doty South Bypass			-0.72	-0.86	-0.93	-1.01	-1.09	-1.18	-1.28	-1.39	-1.16	-1.38	-1.50	-1.63	-1.75	-1.90	-2.06	-2.24
Doty South (BR328)	7.19	7.22	7.19	7.27	7.87	7.87	7.87	7.87	7.87	7.87	11.58	11.70	12.67	12.67	12.67	12.67	12.67	12.67
Auburn Ravine 1 at Head (BR100)	49.86	46.12	50.01	47.10	50.79	54.79	59.11	62.14	65.15	66.50	63.51	59.82	64.50	69.58	75.07	78.92	82.74	84.46
Auburn Ravine 1			2.20	1.77	1.92	2.08	2.25	2.43	2.64	2.85	2.79	2.25	2.44	2.64	2.86	3.09	3.35	3.62
Chevalier Pipe at Head			2.35	1.86	1.86	1.86	1.86	1.86	1.86	1.86	2.98	2.36	2.36	2.36	2.36	2.36	2.36	2.36
Doty Ravine Return Water Addition			-4.55	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-7.33	-5.80	-5.80	-5.80	-5.80	-5.80	-5.80	-5.80
Doty North at Head (BR367)	17.62	16.07	17.62	16.51	17.84	19.27	20.82	21.29	21.81	22.02	21.67	20.31	21.94	23.70	25.61	26.19	26.83	27.08
Doty North 1			1.89	1.76	1.91	2.06	2.23	2.42	2.62	2.83	2.32	2.16	2.35	2.53	2.74	2.98	3.22	3.48
Doty North u/s of Cannon Siphon			15.73	14.75	15.93	17.20	18.59	18.88	19.19	19.19	19.35	18.14	19.59	21.16	22.87	23.22	23.60	23.60
Doty North II			2.98	2.77	3.00	3.25	3.52	3.81	4.12	4.12	3.67	3.41	3.69	4.00	4.33	4.69	5.07	5.07
Doty North d/s of Valley View Reservoir spill to Doty North			12.75	11.98	12.93	13.95	15.07	15.07	15.07	15.07	35.70	33.54	36.20	39.06	42.20	42.20	42.20	42.20
Valley View Spill into Doty North (BR321) Addition	1.13	1.26	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-3.16	-3.16	-3.16	-3.16	-3.16	-3.16	-3.16	-3.16
Comstock at Head			6.67	6.38	6.77	7.20	7.66	7.66	7.66	7.66	13.67	13.08	13.88	14.76	15.70	15.70	15.70	15.70
Comstock u/s of BR116			5.14	4.79	5.19	5.62	6.08	6.08	6.08	6.08	10.54	9.82	10.64	11.52	12.46	12.46	12.46	12.46
Comstock d/s of BR116			1.52	1.59	1.59	1.59	1.59	1.59	1.59	1.59	3.12	3.26	3.26	3.26	3.26	3.26	3.26	3.26
Clark-Jorstad			7.22	6.73	7.29	7.89	8.54	8.54	8.54	8.54	8.88	8.28	8.97	9.70	10.50	10.50	10.50	10.50
Auburn Ravine II at Head (BR369)	27.69	26.46	27.84	26.95	29.18	31.58	34.18	36.55	38.85	39.77	33.41	32.34	35.02	37.90	41.02	43.86	46.62	47.72
Auburn Ravine II (Section 1)			4.77	4.58	4.96	5.37	5.81	6.29	6.81	6.81	5.72	5.50	5.95	6.44	6.97	7.55	8.17	8.17
Lincoln at Head (BR345)	4.16	3.76	4.16	3.84	4.16	4.50	4.87	5.27	5.71	6.18	4.83	4.45	4.83	5.22	5.65	6.11	6.62	7.17
Lincoln 1			2.04	1.88	2.04	2.21	2.39	2.59	2.80	3.03	2.37	2.18	2.37	2.56	2.77	3.00	3.25	3.51
Lincoln 2 (near Ironwood Road)			2.12	1.96	2.12	2.29	2.48	2.69	2.91	3.15	2.46	2.27	2.46	2.66	2.88	3.12	3.38	3.65
Auburn Ravine II u/s of Musser Split			10.66	10.62	11.49	12.44	13.47	14.12	14.83	15.29	12.79	12.74	13.79	14.93	16.16	16.94	17.80	18.35
Musser			2.71	2.60	2.81	3.05	3.30	3.57	3.86	3.86	3.25	3.12	3.37	3.66	3.96	4.28	4.63	4.63
Markell (BR382) including Fruitvale	3.54	3.61	3.54	3.68	3.98	4.31	4.67	5.05	5.47	5.92	4.07	4.23	4.58	4.96	5.37	5.81	6.29	6.81
Hayt at Head (BR348)	4.41	4.25	4.41	4.34	4.70	5.08	5.50	5.50	5.50	5.50	5.12	5.03	5.45	5.89	6.38	6.38	6.38	6.38
Auburn Ravine II d/s of Hayt Canal			8.25	7.91	8.57	9.27	10.04	10.86	11.50	11.50	9.90	9.49	10.28	11.12	12.05	13.03	13.80	13.80
Auburn Ravine II (Section 2)			5.85	5.61	6.07	6.57	7.11	7.70	8.34	8.34	7.02	6.73	7.28	7.88	8.53	9.24	10.01	10.01
Sohier-Ahart			2.40	2.30	2.49	2.70	2.92	3.16	3.16	3.16	2.88	2.76	2.99	3.24	3.50	3.79	3.79	3.79

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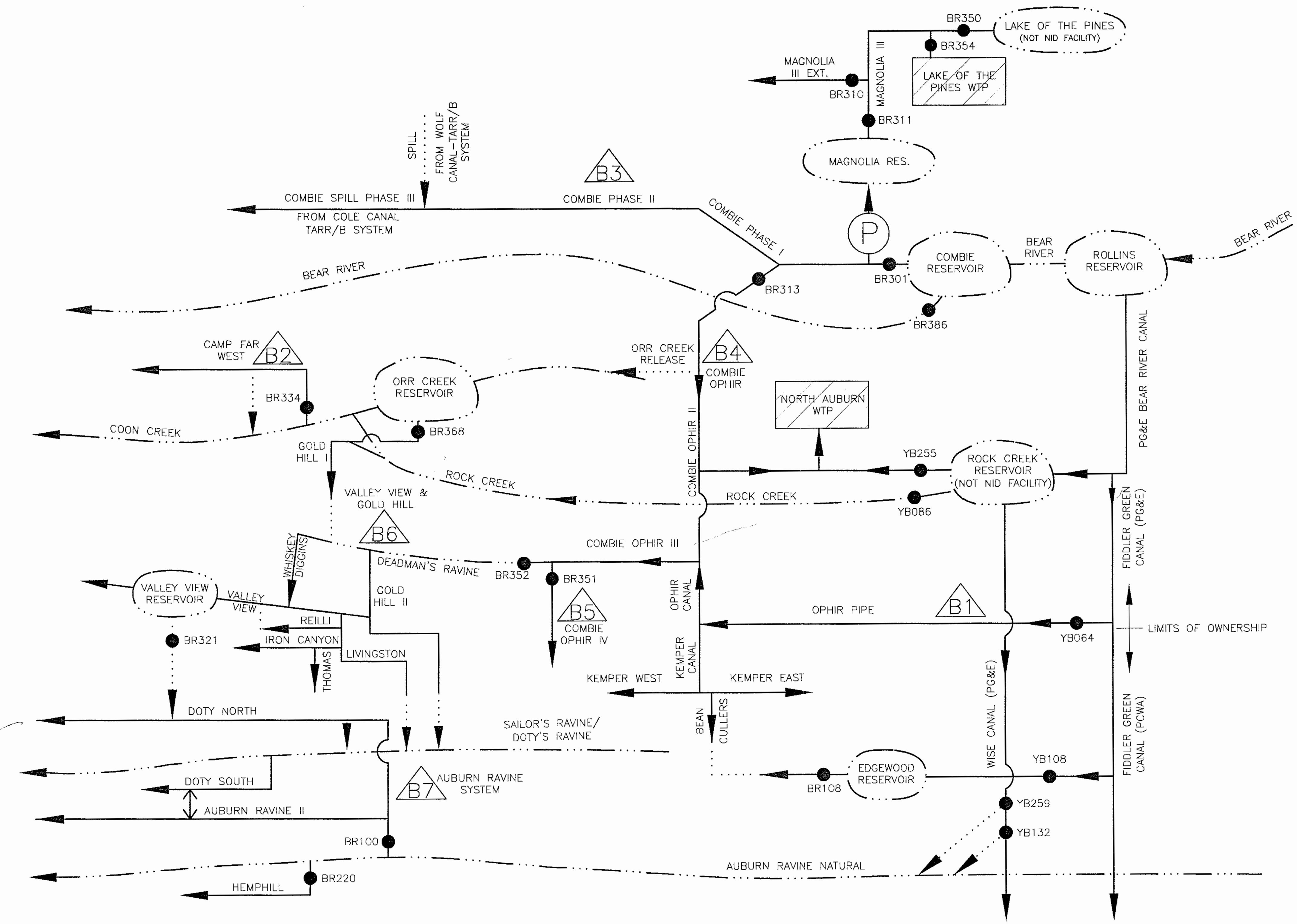
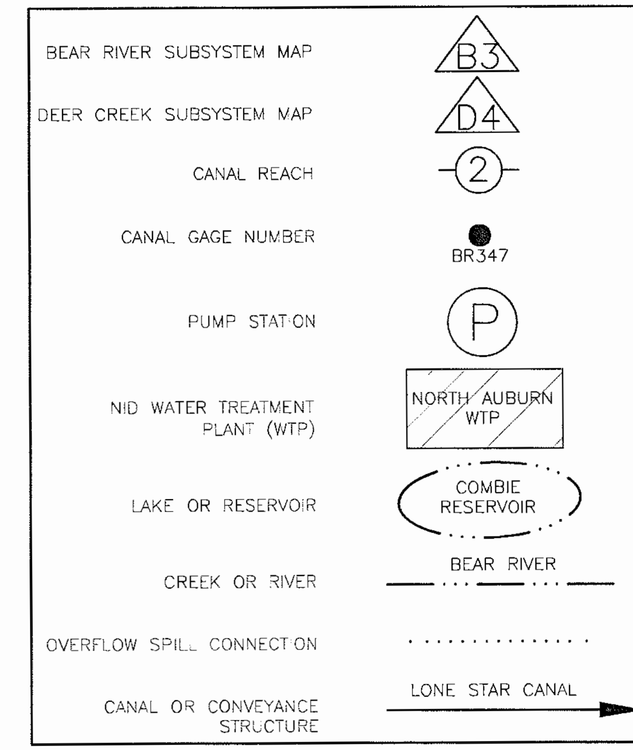
APPENDIX D

PHASE 2 SCHEMATICS



LEGEND



Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
B1 Ophir Pipe (YB064) from PG&E/PCWA Fiddler Green	19.9	20.8	20.9	21.1	21.2	21.3	21.4	21.5
B2 Camp Far West at Head (BR334)	45.1	42.8	46.0	49.5	52.6	55.7	58.7	61.4
B3 Combie Phase 1 at Head (BR301)	125.9	154.3	163.4	178.9	185.8	195.8	203.0	213.2
B4 Combie Ophir I at Head (BR313)	81.9	106.9	112.4	118.0	123.6	129.1	134.9	140.6
B5 Combie Ohpir IV (BR351)	31.9	31.4	32.0	32.5	33.0	33.5	33.9	34.5
B6 Deadman's Ravine at Head (BR352)	24.3	23.0	24.2	25.5	26.9	28.3	29.7	30.7
B7 Auburn Ravine I at Head (BR100)	63.5	59.8	64.5	69.6	75.1	78.9	82.7	84.5

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

NOTE 2: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

NOTE 3: OPHIR PIPE CONTRACTUALLY LIMITED TO 40 CFS.

Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 894-C07	
Filename: Bear-River-2000.dwg	BEAR RIVER SCHEMATIC INDEX PLAN
Drawn By: JAQ	
Date Revised: 08-20-09	INDEX

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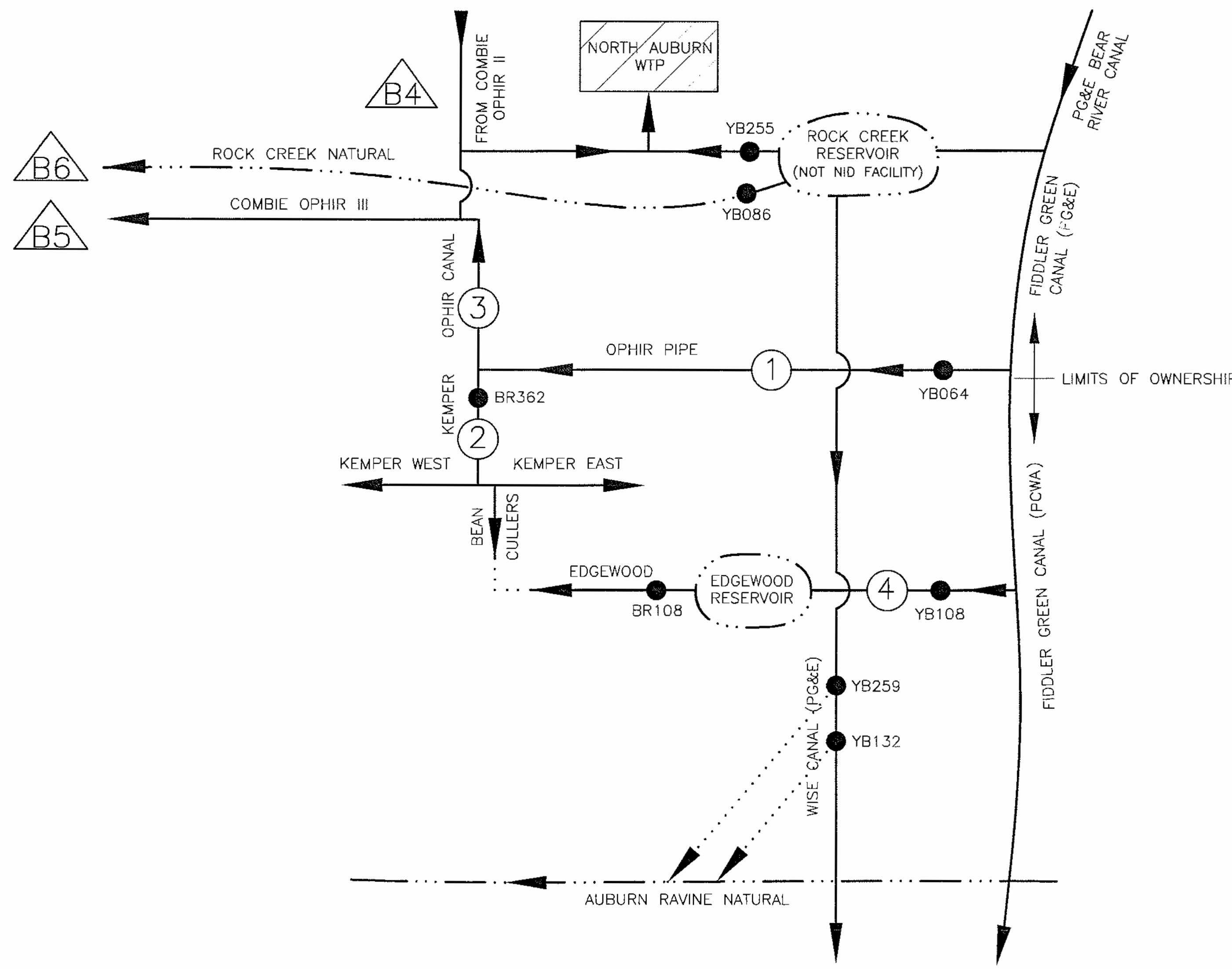

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Ophir Pipe (YB064) from PG&E/PCWA Fiddler Green	19.9	20.8	20.9	21.1	21.2	21.3	21.4	21.5
(2) Kemper West, East, Bean Culler's Canal (BR362)	2.9	3.4	3.4	3.5	3.6	3.7	3.7	3.8
(3) Delivery to Combie Ophir System (YB064 - BR362)	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
(4) Edgewood at Head (YB108)	1.3	1.5	1.5	1.6	1.6	1.6	1.6	1.6

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT
NOTE 2: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

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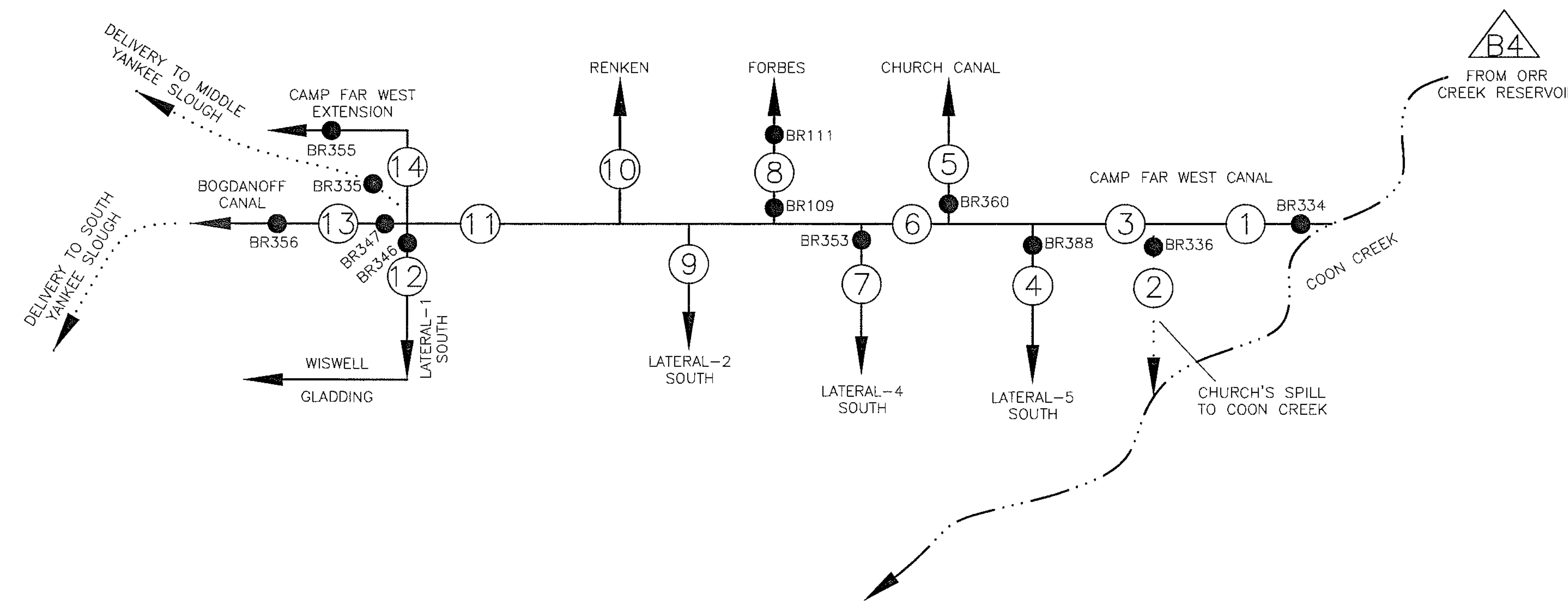
Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 884-007	
Filename: Bear-River-2000.dwg	PG&E/PCWA FACILITIES FLOW SCHEMATIC
Drawn By: JAQ	Kleinschmidt — Energy & Water Resource Consultants — 251 South Auburn Street, Suite C, Grass Valley, California 95945, Telephone: (530) 477-8808, Fax: (530) 477-8885, www.KleinschmidtUSA.com
Date Revised: 08-20-09	B1



	Index	Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
1	Camp Far West at Head (BR334)	45.1	42.8	46.0	49.5	52.6	55.7	58.7	61.4
2	Coon Creek d/s of Church's Spill (BR336)	15.8	9.8	10.5	11.1	11.9	12.6	13.5	14.4
3	Camp Far West d/s of Church's Spill	24.9	26.7	28.8	31.2	33.1	34.8	36.5	37.8
4	Lateral 5 South at Head (BR388)	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8
5	Church Lateral at Head (BR360)	0.4	1.0	1.0	1.1	1.2	1.2	1.3	1.4
6	Camp Far West d/s of Church Lateral/Forbes Rd	21.7	22.8	24.7	26.9	28.6	30.1	31.5	32.5
7	Lateral 4 South at Head (BR353)	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1
8	Forbes at Head (BR109)	1.7	2.0	2.1	2.2	2.4	2.5	2.7	2.7
9	Lateral 2 South at Head	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10	Renken at Head	1.0	1.0	1.0	1.1	1.2	1.3	1.3	1.3
11	Camp Far West & Ext. (u/s of Bogdanoff & Lat 1)	13.6	14.2	15.2	16.3	17.5	18.8	20.0	21.0
12	Lateral 1 South at Head (BR346)	4.5	4.9	5.2	5.6	6.0	6.3	6.8	6.9
13	Bogdanoff at Head (BR347)	2.4	2.4	2.5	2.7	2.8	3.0	3.2	3.4
14	Camp Far West Extension (d/s of Split)	1.1	1.3	1.3	1.4	1.5	1.6	1.6	1.6

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

NOTE 2: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

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Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 894-007	
Filename: Bear-River-2000.dwg	CAMP FAR WEST FLOW SCHEMATIC
Drawn By: JAQ	Kleinschmidt — Energy & Water Resource Consultants
Date Revised: 08-20-09	B2

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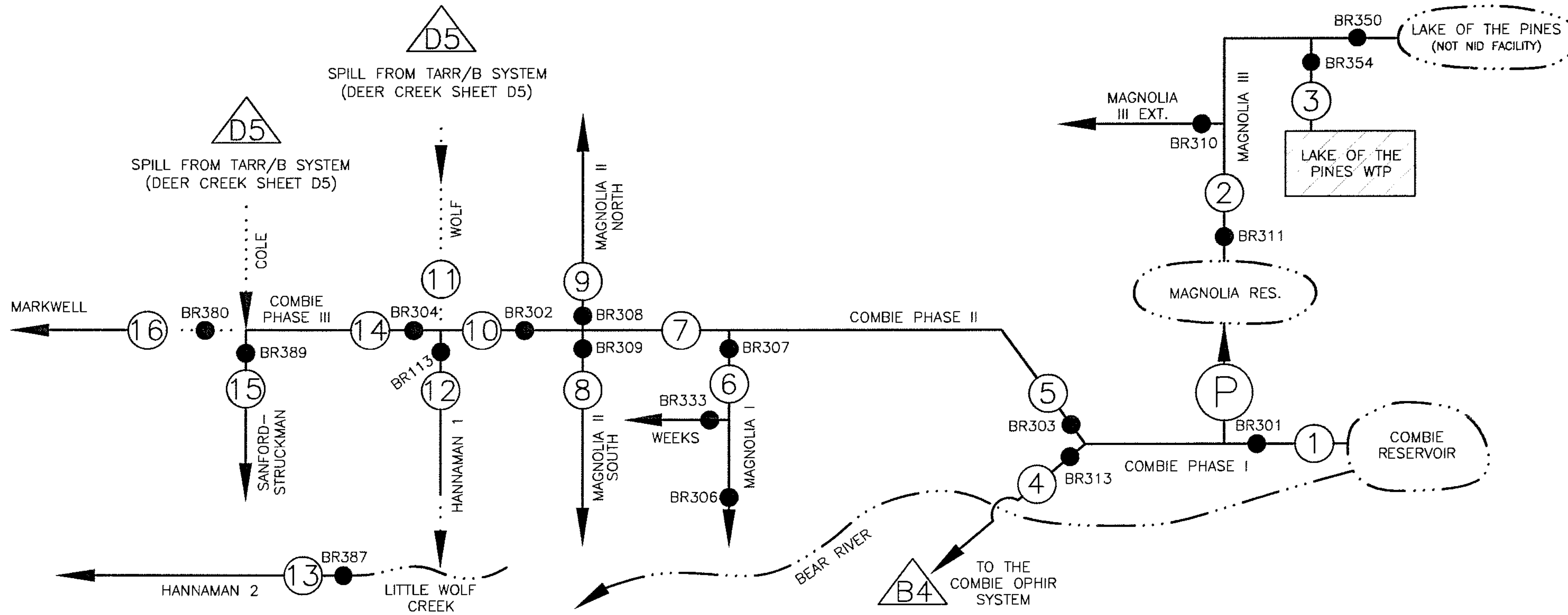

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Combie Phase 1 at Head (BR301)	125.9	154.3	163.4	178.9	185.8	195.8	203.0	213.2
(2) Magnolia III at Head (BR311) w/ Magnolia III Ext.	11.5	11.1	14.5	18.0	18.6	19.2	19.9	20.6
(3) Delivery to Lake of the Pines WTP (BR354)	6.0	6.1	6.6	7.1	7.7	8.4	9.0	9.8
(4) Combie Ophir I at Head (BR313)	81.9	106.9	112.4	118.0	123.6	129.1	134.9	140.6
(5) Combie Phase II at Head (BR303)	32.0	32.2	32.9	33.6	34.3	35.1	35.8	36.6
(6) Magnolia I at Head (BR307) including Weeks	0.9	1.0	1.1	1.1	1.1	1.1	1.2	1.2
(7) Combie Phase II Canal at Wolf Creek Siphon	32.6	32.7	33.4	34.2	34.9	35.7	36.4	37.2
(8) Magnolia II South at Head (BR309)	1.7	1.8	1.9	1.9	1.9	2.0	2.0	2.1
(9) Magnolia II North at Head (BR308)	1.9	1.7	1.7	1.8	1.8	1.8	1.9	1.9
(10) Combie Phase II, III Above Wolf Canal (BR302)	23.3	22.8	23.3	23.8	24.4	24.9	25.5	26.0
(11) Wolf Canal Return Water (Addition into System)	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7
(12) Hannaman I at Head (BR113)	7.4	7.3	7.5	7.6	7.8	7.9	8.1	8.3
(13) Hannaman II at Head (BR387)	4.0	5.0	5.1	5.2	5.3	5.4	5.5	5.6
(14) Combie Phase III at Head (BR304) d/s of Wolf	18.1	17.8	18.1	18.5	18.9	19.2	19.6	20.0
(15) Sanford Struckman Canal at Head (BR389)	5.4	5.6	5.7	5.9	6.0	6.1	6.2	6.4
(16) Markwell at Head (BR380)	8.6	8.5	8.7	8.8	9.0	9.2	9.4	9.6

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

NOTE 2: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

Scale: NTS
Project No: 894-007
Filename: Bear-River-2000.dwg
Drawn By: JAQ
Date Revised: 08-20-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

COMBIE PHASE I, II, & III FLOW SCHEMATIC

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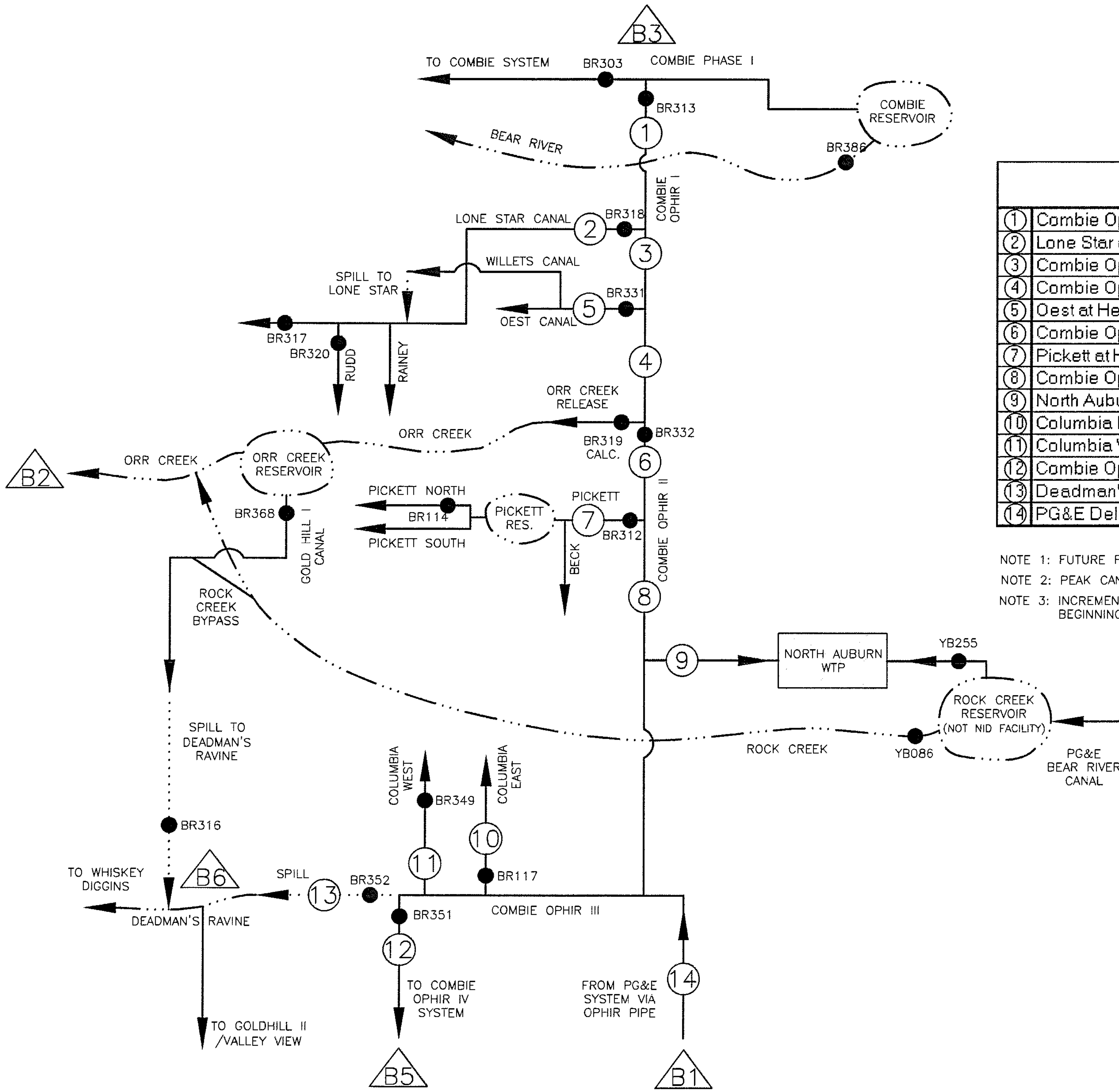

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Combie Ophir I at Head (BR313)	81.9	106.9	112.4	118	123.6	129.1	134.9	140.6
(2) Lone Star at Head (BR318) including Rainey	6.484	6.983	7.25	7.528	7.528	7.528	7.528	7.528
(3) Combie Ophir I d/s of Lone Star Canal	74.9	99.39	104.6	109.9	115.5	121	126.8	132.5
(4) Combie Ophir I & Orr Creek Release (combined)	69.13	99.71	105.1	110.6	116.5	122.6	129.1	135.6
(5) Oest at Head (BR331) including Willets Canal	5.472	5.278	5.563	5.86	6.167	6.167	6.167	6.167
(6) Combie Ophir II at Head (BR332)	46.51	46.01	47.85	49.63	51.49	53.42	55.33	56.96
(7) Pickett at Head (BR312) including Beck Canal	2.463	2.238	2.35	2.475	2.613	2.75	2.888	3.05
(8) Combie Ophir II at Dry Creek Siphon Inlet	42.58	41.48	43.08	44.61	46.2	47.85	49.47	50.78
(9) North Auburn WTP	7.4	7.575	8.825	9.9	10.78	11.5	12.05	12.43
(10) Columbia East at Head (BR117)	0.796	0.784	0.831	0.878	0.924	0.971	1.018	1.076
(11) Columbia West at Head	0.374	0.573	0.597	0.632	0.667	0.702	0.737	0.737
(12) Combie Ophir IV at Head (BR351)	31.88	31.43	32.02	32.49	32.97	33.45	33.95	34.47
(13) Deadman's Ravine at Head (BR352)	24.3	22.95	24.21	25.51	26.88	28.32	29.69	30.68
(14) PG&E Delivery (via Ophir Pipe) Addition	-14.1	-14.1	-14.1	-14.1	-14.1	-14.1	-14.1	-14.1

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

NOTE 2: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

NOTE 3: INCREMENTAL FLOWS FROM THE REGIONAL WATER TREATMENT FACILITY ARE INCLUDED AT THE HEAD OF THE COMBIE PHASE I BEGINNING IN 2015. THE FACILITY DOES NOT REACH BUILD OUT DURING THE PLANNING PERIOD.

Scale: NTS
Project No: 894-007
Filename: Bear-River-2000.dwg
Drawn By: JAQ
Date Revised: 11-4-11

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

COMBIE OPHIR I, II, & III FLOW SCHEMATIC

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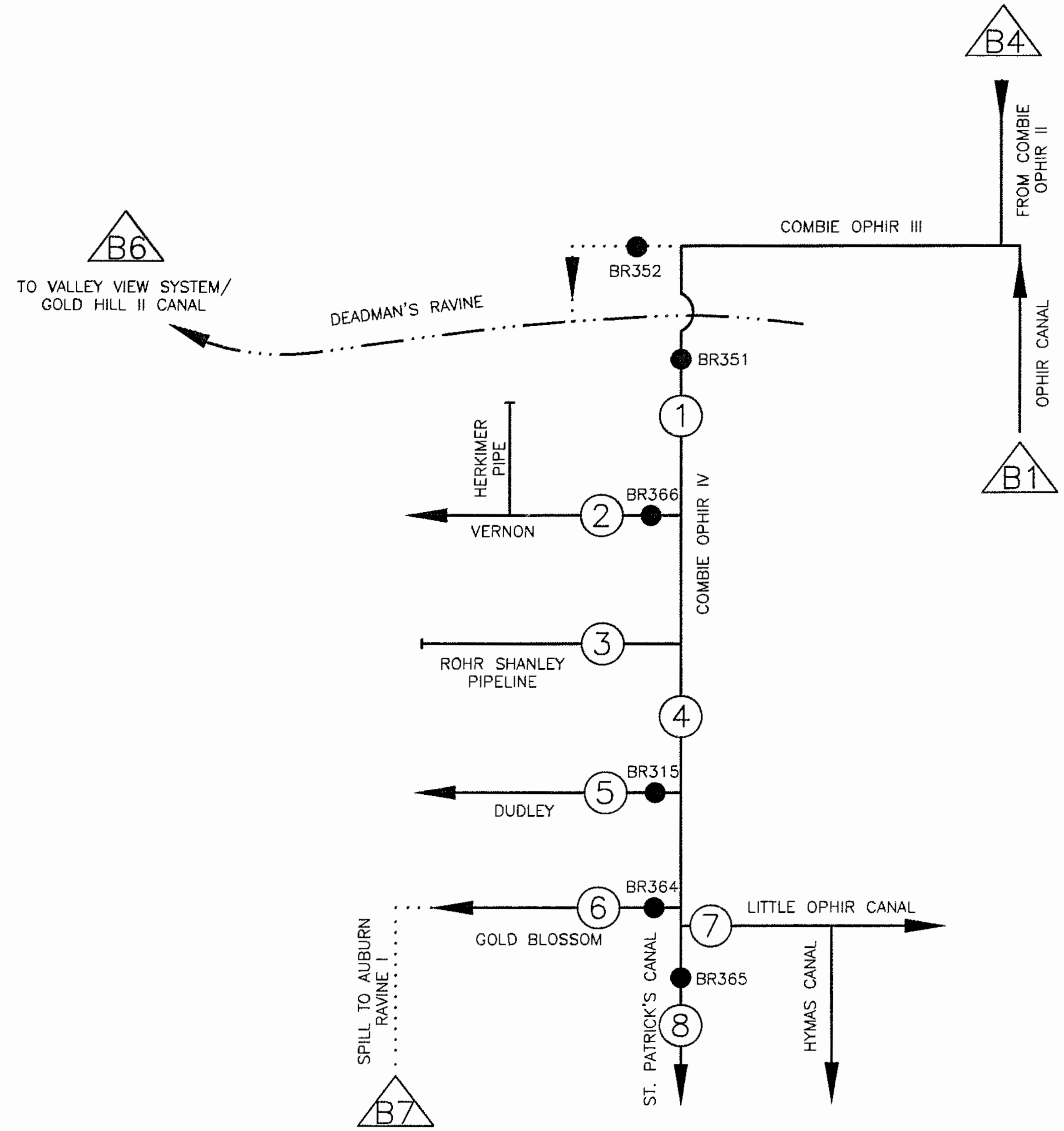

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Combie Ohpir IV (BR351)	31.9	31.4	32.0	32.5	33.0	33.5	33.9	34.5
(2) Mt. Vernon at Head (BR366)	6.1	6.5	6.7	6.7	6.7	6.7	6.7	6.7
(3) Rohr Shanley Pipeline	1.9	2.2	2.2	2.2	2.2	2.2	2.2	2.2
(4) Combie Ophir IV d/s of Rohr Shanley Pipeline	24.1	22.9	23.3	23.8	24.3	24.7	25.2	25.7
(5) Dudley at Head (BR315)	9.1	8.8	9.0	9.2	9.3	9.5	9.7	9.9
(6) Gold Blossom at Head (BR364)	8.5	7.3	7.5	7.6	7.8	7.9	8.1	8.2
(7) Little Ophir at Head (including Hymas Canal)	2.5	2.7	2.7	2.8	2.8	2.9	2.9	3.0
(8) St. Patrick's at Head (BR365)	1.3	1.2	1.2	1.3	1.3	1.3	1.3	1.4

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT
NOTE 2: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

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Scale: NTS
Project No: 894-007
Filename: Bear-River-2000.dwg
Drawn By: JAQ
Date Revised: 08-20-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

COMBIE OPHIR IV FLOW SCHEMATIC

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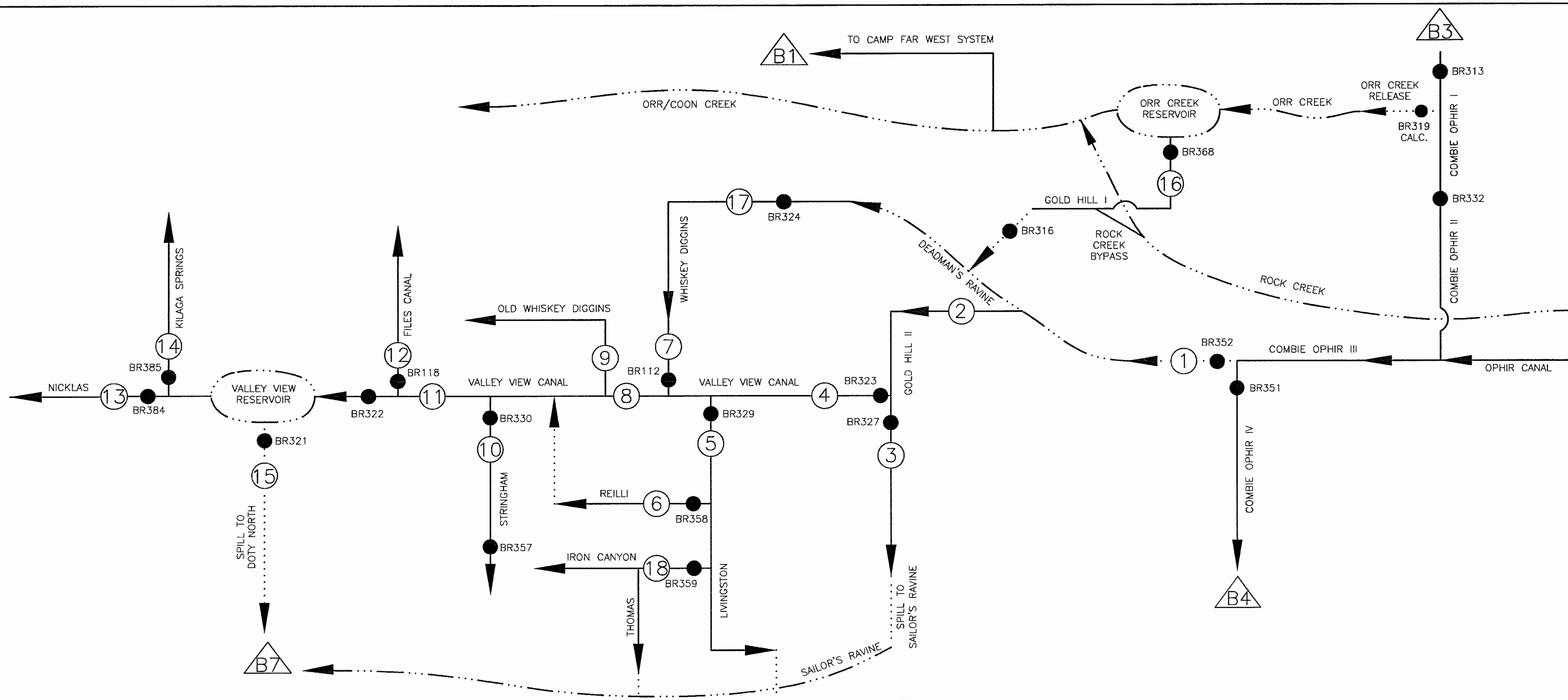

Index		Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
1	Deadman's Ravine at Head (BR352)	24.3	23.0	24.2	25.5	26.9	28.3	29.7	30.7
2	Gold Hill II at Deadman's Ravine Diversion	16.8	16.9	17.6	18.3	19.0	19.7	20.4	20.8
3	Lower Gold Hill II at BR327 to Sailor's Ravine	4.6	5.4	5.7	6.0	6.3	6.7	7.0	7.0
4	Valley View at Head (BR323)	11.4	10.7	11.1	11.4	11.8	12.2	12.5	12.8
5	Livingston at Head (BR329)	8.3	7.9	8.1	8.3	8.5	8.8	9.0	9.3
6	Reilli at Head (BR358)	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.6
7	Addition of Whiskey Diggins at End (BR112)	-5.2	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9
8	Valley View d/s of Whiskey Diggins (BR112)	7.2	7.6	7.7	7.8	8.0	8.1	8.2	8.2
9	Old Whiskey Diggins at Head	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
10	Stringham at Head	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3
11	Valley View d/s of Stringham	5.6	5.9	6.0	6.1	6.2	6.3	6.4	6.4
12	Files at Head (BR118)	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
13	Nicklas at Head (BR384)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
14	Kilaga Springs at Head (BR385)	1.3	1.5	1.5	1.6	1.7	1.8	1.8	1.8
15	Vallew View Spill to Doty North (BR321)	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
16	Gold Hill I at Head d/s of Orr Creek Reservoir (BR368)	9.7	9.9	10.5	11.0	11.6	11.6	11.6	11.6
17	Whiskey Diggins at Head (BR324)	7.2	7.1	7.4	7.8	8.2	8.7	9.1	9.6
18	Iron Canyon at Head (BR359)	1.1	1.5	1.6	1.6	1.7	1.8	1.9	2.0

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

NOTE 2: NEGATIVE FLOWS FOR WHISKEY DIGGENS AT END SIGNIFY SPILLAGE TO VALLEY VIEW CANAL

NOTE 3: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 894-007	
Filename: Bear-River-2000.dwg	VALLEY VIEW & GOLD HILL FLOW SCHEMATIC
Drawn By: JAQ	**Kleinschmidt** Energy & Water Resource Consultants
Date Revised: 08-20-09	B6

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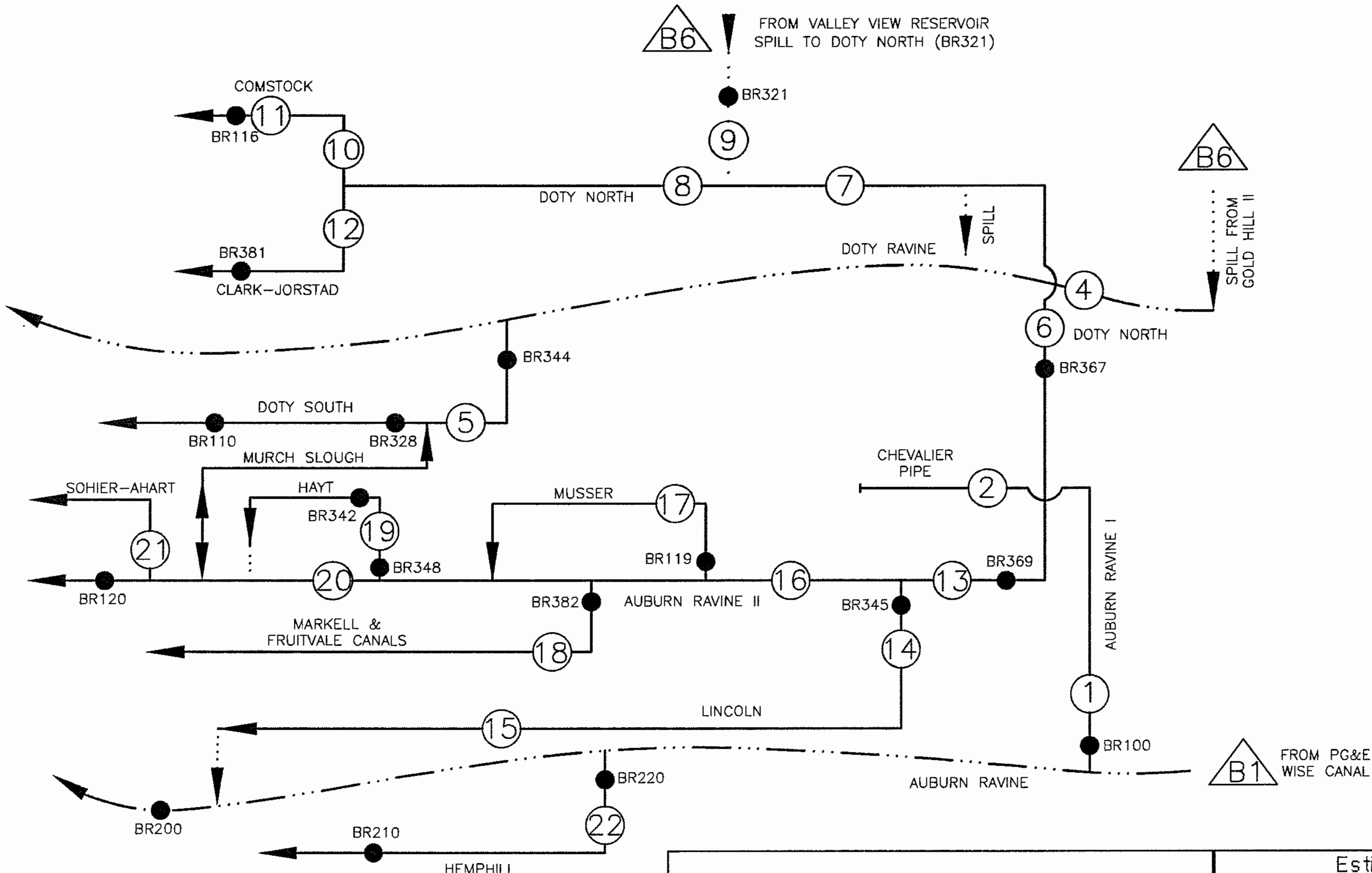

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Auburn Ravine I at Head (BR100)	63.5	59.8	64.5	69.6	75.1	78.9	82.7	84.5
(2) Chevalier Pipe at Head	3.0	2.4	2.4	2.4	2.4	2.4	2.4	2.4
(4) Doty Ravine Return Water Addition	-7.3	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8
(5) Doty South at Head (BR344)	10.4	10.3	11.2	11.0	10.9	10.8	10.6	10.4
(6) Doty North at Head (BR367)	21.7	20.3	21.9	23.7	25.6	26.2	26.8	27.1
(7) Doty North u/s of Cannon Siphon	19.3	18.1	19.6	21.2	22.9	23.2	23.6	23.6
(8) Doty North d/s of V.V. Reservoir Spill to Doty North	35.7	33.5	36.2	39.1	42.2	42.2	42.2	42.2
(9) V.V. Spill into Doty North (BR321) Addition	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2
(10) Comstock at Head	13.7	13.1	13.9	14.8	15.7	15.7	15.7	15.7
(11) Comstock d/s of BR116	3.1	3.3	3.3	3.3	3.3	3.3	3.3	3.3
(12) Clark-Jorstad at Head	8.9	8.3	9.0	9.7	10.5	10.5	10.5	10.5
(13) Auburn Ravine II at Head (BR369)	33.4	32.3	35.0	37.9	41.0	43.9	46.6	47.7
(14) Lincoln at Head (BR345)	4.8	4.5	4.8	5.2	5.6	6.1	6.6	7.2
(15) Lincoln (near Ironwood Road)	2.5	2.3	2.5	2.7	2.9	3.1	3.4	3.7
(16) Auburn Ravine II u/s of Musser Split	27.8	27.0	29.2	31.6	34.2	36.5	38.9	39.8
(17) Musser at Head (BR119)	3.3	3.1	3.4	3.7	4.0	4.3	4.6	4.6
(18) Markell (BR382) including Fruitvale	4.1	4.2	4.6	5.0	5.4	5.8	6.3	6.8
(19) Hayt at Head (BR348)	5.1	5.0	5.5	5.9	6.4	6.4	6.4	6.4
(20) Auburn Ravine II d/s of Hayt Canal	9.9	9.5	10.3	11.1	12.0	13.0	13.8	13.8
(21) Sohier-Ahart	2.9	2.8	3.0	3.2	3.5	3.8	3.8	3.8
(22) Hemphill at Head (BR220)	12.4	11.2	12.1	13.1	14.2	15.4	16.6	18.0

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

NOTE 2: NEGATIVE FLOWS FOR VALLEY VIEW AT END SIGNIFY SPILLAGE TO DOTY NORTH CANAL

NOTE 3: PEAK CANAL FLOWS DO NOT INCLUDE POTENTIAL FLOWS FOR THE REGIONAL WATER TREATMENT FACILITY.

Scale: NTS
Project No: 894-007
Filename: Bear-River-2000.dwg
Drawn By: JAQ
Date Revised: 11-4-11

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

AUBURN RAVINE
FLOW SCHEMATIC

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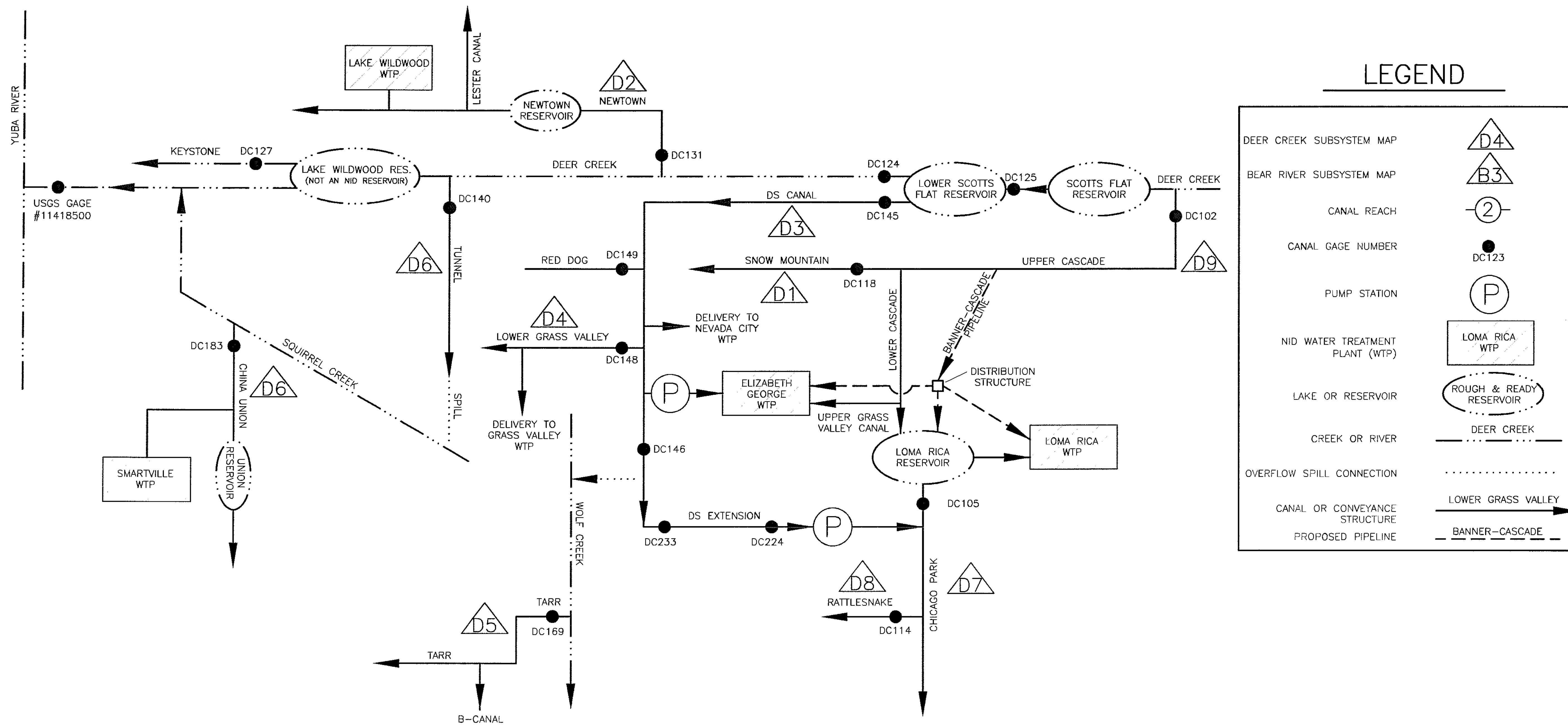

Index		Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
D1	Snow Mountain Canal at Head (DC118)	4.8	4.9	5.3	5.6	6.0	6.4	6.7	6.9
D2	Newtown Canal at Head (DC131)	14.5	15.5	16.4	17.4	18.5	19.7	21.1	22.7
D3	DS Canal at Head (DC145)	75.7	66.6	71.8	75.9	80.2	84.8	89.7	94.8
D4	Lower Grass Valley at Head (DC148)	13.6	13.8	15.9	16.8	17.8	18.8	20.0	21.3
D5	Tarr Canal at Head (DC169)	54.8	53.9	55.5	57.1	58.7	60.3	61.7	63.2
D6	Tunnel System (DC140+DC127+DC183)	43.7	43.5	45.8	48.7	49.8	50.9	52.0	53.2
D7	Chicago Park at Head (DC105)	30.5	30.9	35.3	40.9	44.1	47.1	49.6	52.3
D8	Rattlesnake Canal at Head (DC114)	12.1	12.6	15.4	19.3	20.9	22.1	23.0	24.0
D9	Cascade Canal at Head (DC102)	55.0	59.1	66.6	75.2	81.0	85.6	88.3	91.2

Scale: NTS
Project No: 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 11-4-11

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

DEER CREEK SCHEMATIC INDEX PLAN

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INDEX

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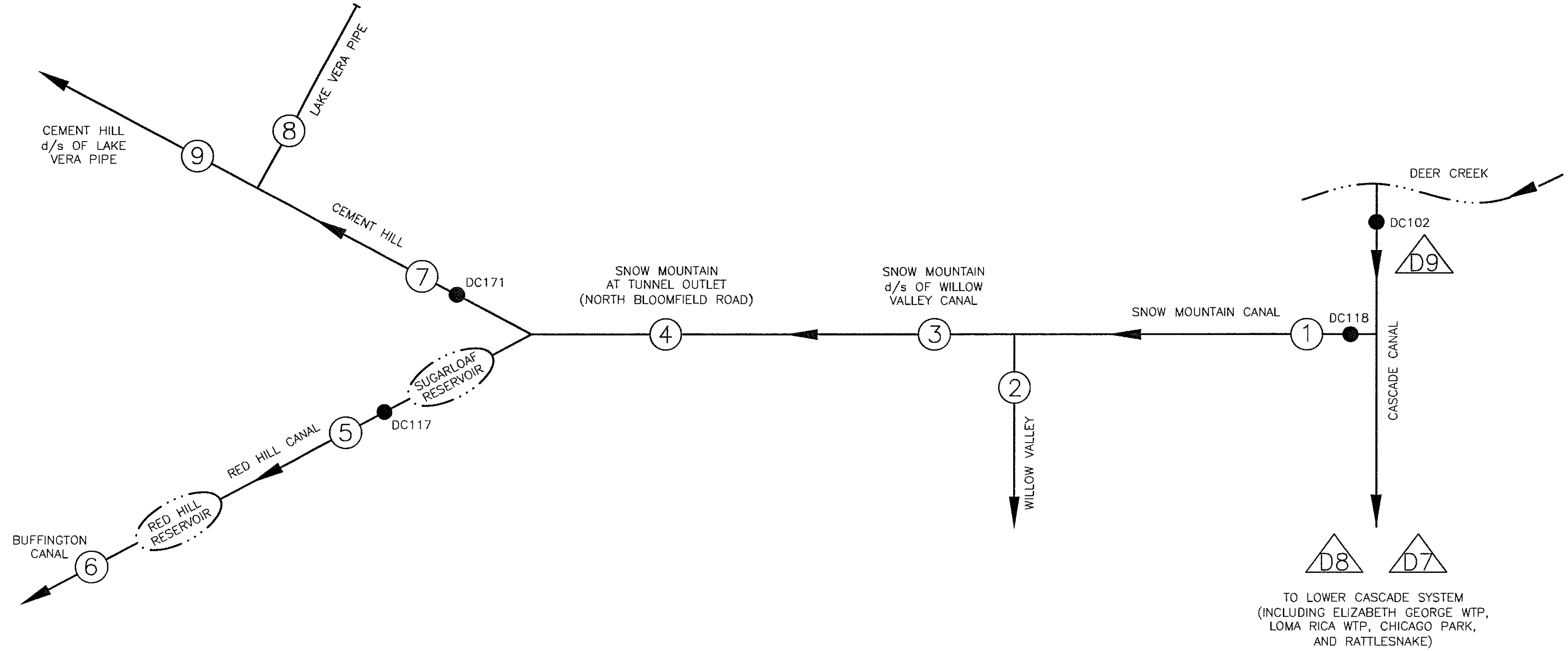

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Snow Mountain Canal at Head (DC118)	4.8	4.9	5.3	5.6	6.0	6.4	6.7	6.9
(2) Willow Valley at Head	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
(3) Snow Mountain d/s of Willow Valley	3.9	4.0	4.3	4.6	4.9	5.2	5.4	5.5
(4) Snow Mountain at Tunnel Outlet	3.7	3.8	4.0	4.3	4.5	4.8	5.0	5.1
(5) Red Hill at Head (DC117)	1.5	1.6	1.7	1.8	1.9	2.0	2.0	2.1
(6) Buffington Canal	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
(7) Cement Hill at Head (DC171)	2.0	2.0	2.1	2.2	2.4	2.5	2.7	2.7
(8) Lake Vera Pipe at Head	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(9) Cement Hill d/s of Lake Vera Pipe	1.5	1.4	1.6	1.7	1.8	2.0	2.1	2.1

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

Scale: NTS
Project No: 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 08-17-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

SNOW MOUNTAIN FLOW SCHEMATIC

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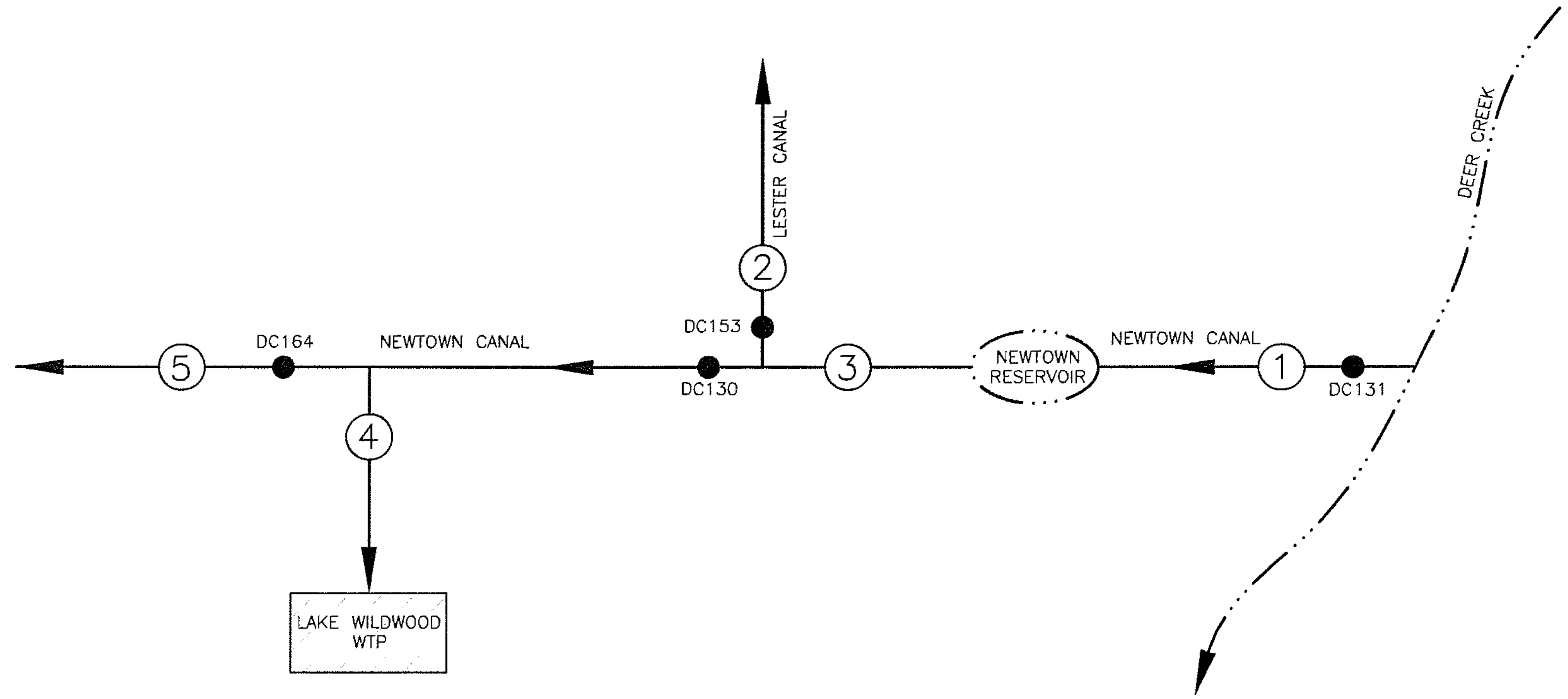

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Newtown Canal at Head (DC131)	14.5	15.5	16.4	17.4	18.5	19.7	21.1	22.7
(2) Lester Canal at Head (DC153)	1.5	1.7	1.7	1.8	1.9	2.0	2.0	2.1
(3) Newtown Canal d/s of Reservoir (DC130)	12.0	11.4	12.1	12.9	13.8	14.9	16.1	17.5
(4) Delivery to Lake Wildwood WTP	7.2	7.4	8.2	9.1	10.3	11.7	13.3	15.5
(5) Newtown Canal (DC164)	3.5	3.4	3.5	3.7	3.8	4.0	4.2	4.3

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

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Scale: NTS
Project No: 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 08-17-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

NEWTOWN CANAL FLOW SCHEMATIC

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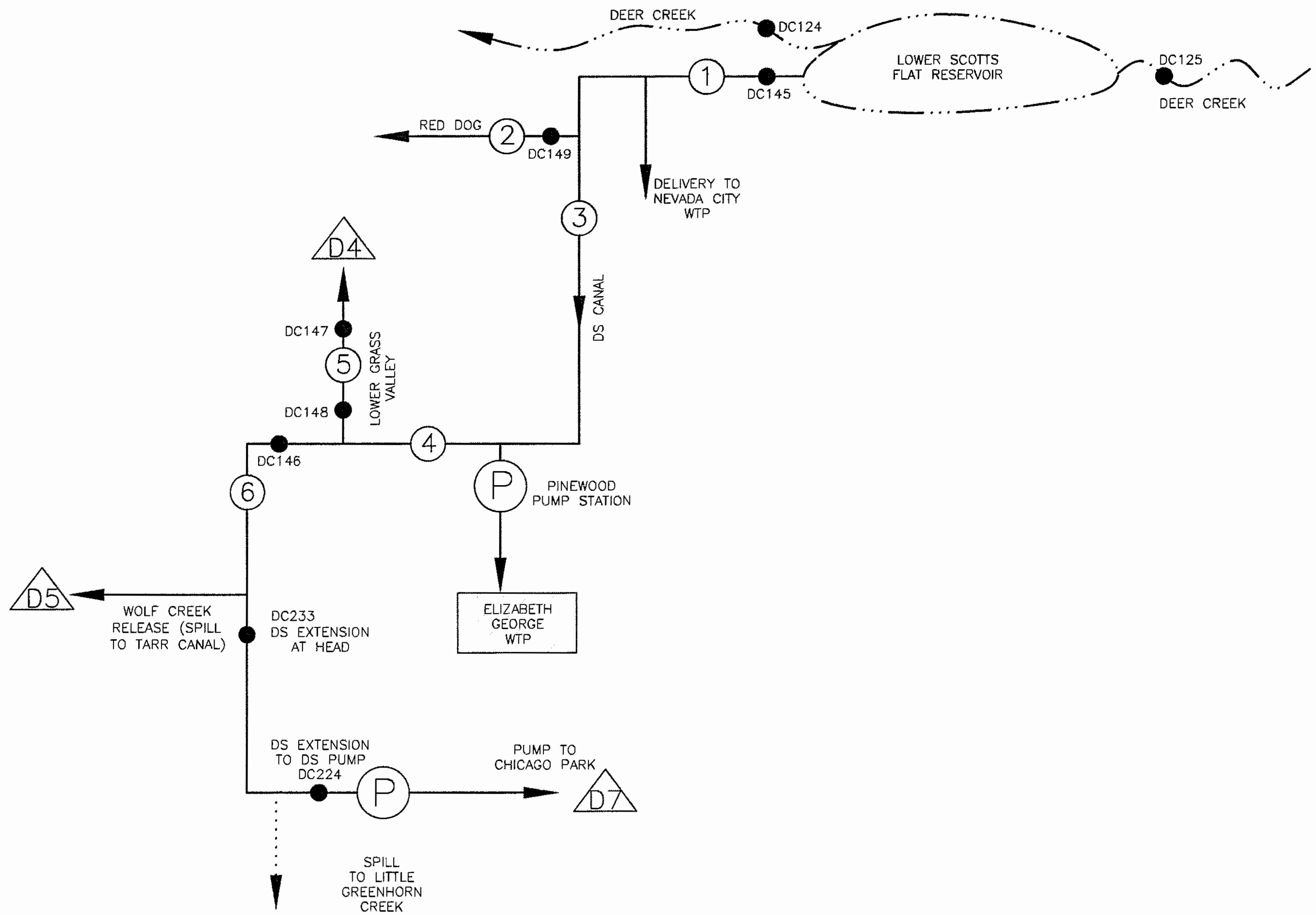
D2



	Index	Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
1	DS Canal at Head (DC145)	75.2	66.0	71.4	75.5	80.0	84.6	89.6	94.9
2	Red Dog Canal at Head (DC149)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3	DS Canal Below Red Dog Road	73.7	64.7	69.8	73.8	78.0	82.4	87.1	92.0
4	DS Canal Below Pinewood Pumps to E. George WTP	71.5	65.1	70.3	74.4	78.6	83.0	87.7	92.7
5	Lower Grass Valley at Head (DC148)	13.6	13.8	15.9	16.8	17.8	18.8	20.0	21.3
6	DS Canal at Town Talk (DC146)	53.4	49.7	52.6	55.7	58.8	62.1	65.6	69.1

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

Scale: NTS
Project No: 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 11-05-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

DS CANAL FLOW SCHEMATIC

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D3

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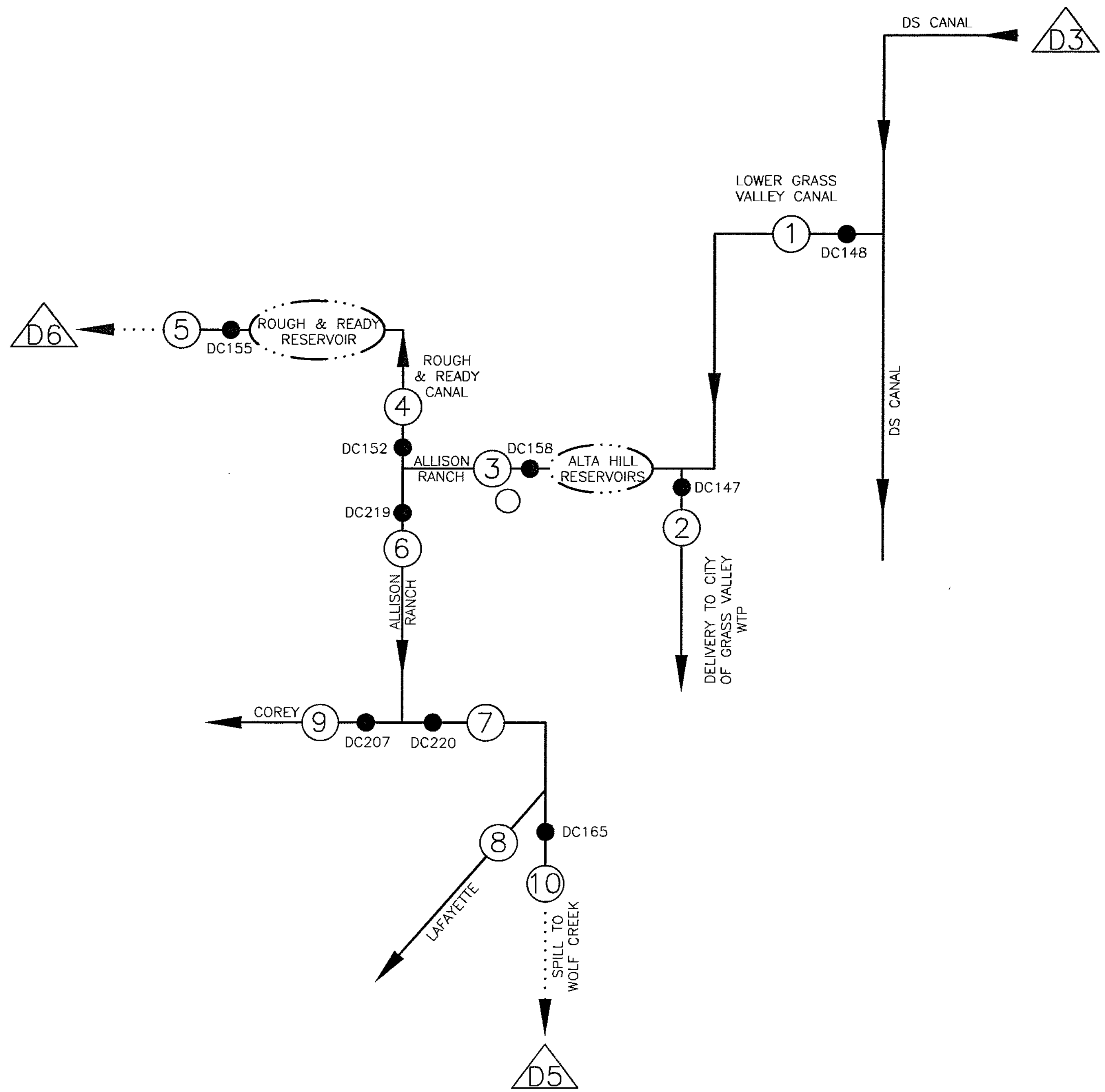

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Lower Grass Valley at Head (DC148)	13.6	13.8	15.9	16.8	17.8	18.8	20.0	21.3
(2) Delivery to City of Grass Valley WTP (DC147)	3.5	3.6	4.0	4.6	5.1	5.8	6.6	7.4
(3) Allison Ranch Canal at Head (DC158)	8.4	8.8	10.4	10.8	11.3	11.7	12.2	12.8
(4) Rough and Ready Canal at Head (DC152)	3.9	4.2	5.6	5.9	6.2	6.5	6.9	7.2
(5) Rough and Ready Canal at Reservoir Release (DC155)	1.5	1.7	1.8	2.0	2.1	2.3	2.5	2.7
(6) Allison Ranch d/s of R&R Split & CCC Reservoir (DC219)	5.1	5.2	5.4	5.6	5.8	5.9	6.1	6.3
(7) Allison Ranch Canal at Fairgrounds (DC220)	3.0	3.2	3.3	3.4	3.4	3.4	3.4	3.5
(8) Lafayette Canal at Head	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.4
(9) Corey Canal at Head (DC207)	1.8	1.7	1.8	1.9	2.0	2.2	2.3	2.4
(10) Allison Ranch at End (DC165)	0.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

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Scale: NTS
Project No: 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 08-20-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

LOWER GRASS VALLEY CANAL
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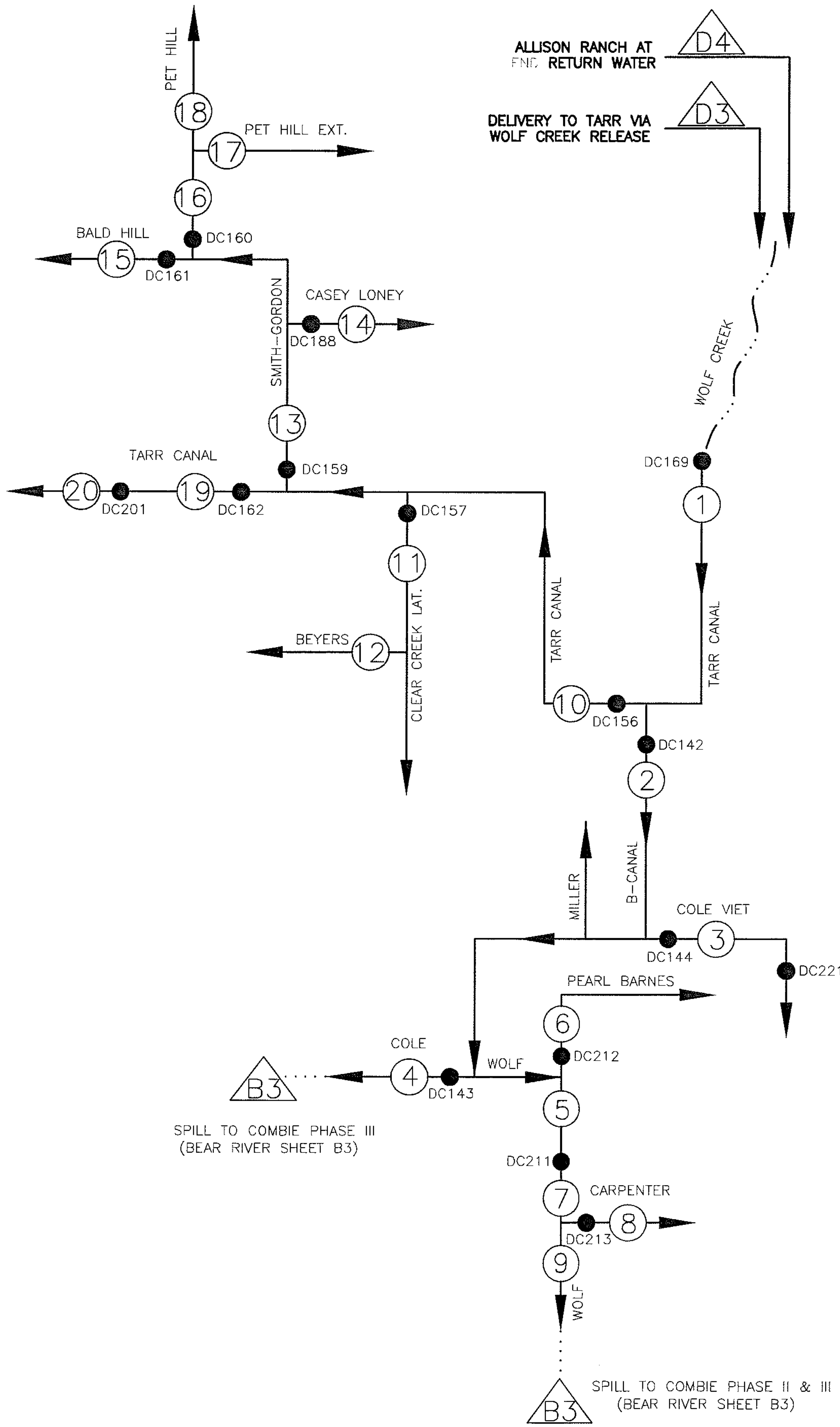

Index		Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
1	Tarr Canal at Head (DC169)	54.8	53.9	55.5	57.1	58.7	60.3	61.7	63.2
2	B Canal at Head (DC142)	17.7	17.4	18.1	18.9	19.6	20.3	20.8	21.3
3	Cole Viet Canal at Head (DC144)	2.9	2.9	3.0	3.1	3.2	3.3	3.5	3.6
4	Cole Canal at Head (DC143)	5.2	5.6	5.8	6.0	6.3	6.5	6.8	7.1
5	Wolf Canal at Head	5.5	5.5	5.7	5.9	6.2	6.3	6.4	6.6
6	Pearl Barnes Canal at Head (DC212)	0.9	1.0	1.0	1.0	1.1	1.1	1.2	1.2
7	Wolf Canal at Wolf Road (DC 211)	4.5	4.5	4.7	4.9	5.1	5.2	5.3	5.4
8	Carpenter Canal at Head (DC213)	1.9	1.9	2.0	2.1	2.2	2.3	2.3	2.5
9	Wolf Canal (d/s of Carpenter Canal)	2.6	2.5	2.6	2.7	2.8	2.8	2.8	2.8
10	Tarr Canal at Hog Chute (DC156)	35.0	35.6	36.5	37.3	38.2	39.1	40.1	41.0
11	Clear Creek Lateral at Head (DC157)	7.1	6.6	6.9	7.1	7.4	7.7	8.1	8.4
12	Beyers Canal at Head	2.5	2.3	2.4	2.5	2.6	2.7	2.9	3.0
13	Smith-Gordon Canal at Head (DC159)	9.7	9.7	10.0	10.3	10.6	10.9	11.3	11.7
14	Casey Loney Canal (& Stinson) at head (DC188)	1.2	1.0	1.0	1.1	1.1	1.1	1.1	1.2
15	Bald Hill Canal at Head (DC161)	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8
16	Pet Hill Canal at Head (DC160)	3.0	3.0	3.1	3.2	3.4	3.5	3.6	3.8
17	Pet Hill Extension at Head	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
18	Pet Hill Canal d/s of Highway 20	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7
19	Tarr Canal d/s of Smith-Gordon Canal (DC162)	10.9	11.6	11.6	11.7	11.7	11.8	11.8	11.8
20	Tarr Canal above Jaureguis (DC201)	7.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

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Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 894-C07	
Filename: Deer-Creek-2000.dwg	TARR CANAL FLOW SCHEMATIC
Drawn By: JAQ	Kleinschmidt Energy & Water Resource Consultants
Date Revised: 08-17-09	D5

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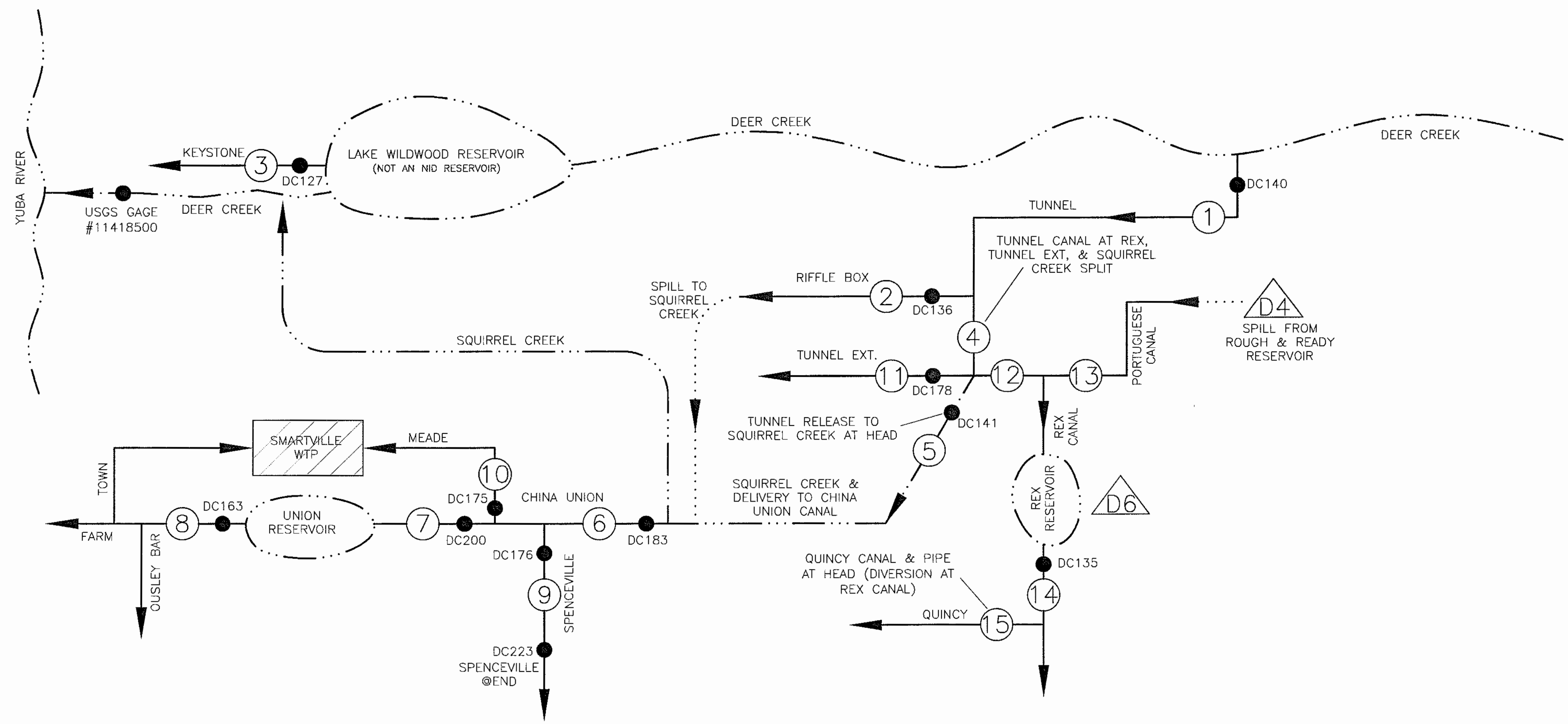

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Tunnel System (DC140+DC127+DC183)	43.7	43.5	45.8	48.7	49.8	50.9	52.0	53.2
(2) Riffle Box Canal at Head (DC136)	4.8	5.9	6.0	6.2	6.3	6.4	6.6	6.7
(3) Keystone Canal at Head (DC127)	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1
(4) Tunnel Canal at Rex, Tunnel Ext, & Squirrel Creek Split	20.3	19.0	19.5	20.0	20.6	21.2	21.8	22.4
(5) Tunnel Release to Squirrel Creek at Head (DC141)	12.8	10.6	11.1	11.5	12.0	12.4	12.9	13.5
(6) China Union at Head (DC183)	13.7	13.6	15.2	17.4	17.6	17.9	18.1	18.3
(7) China Union at Mooney Flat (DC200)	7.8	7.5	7.6	7.8	7.9	8.1	8.2	8.4
(8) Farm Canal at Head (DC163)	4.0	4.1	4.2	4.2	4.3	4.4	4.5	4.6
(9) Spenceville Canal at Head (DC176)	3.7	3.6	3.7	3.8	3.8	3.9	4.0	4.1
(10) Meade Canal at Head (DC175)	1.7	1.7	1.8	1.8	1.9	1.9	1.9	2.0
(11) Tunnel Extension at Head (DC178)	2.8	2.9	3.0	3.0	3.1	3.2	3.2	3.3
(12) Rex Canal at Head	10.7	10.3	10.5	10.8	11.1	11.3	11.6	11.9
(13) Portuguese Canal at Head	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
(14) Rex Canal at DC135 (Reservoir Outlet)	6.7	6.6	6.7	6.8	6.8	6.9	7.0	7.1
(15) Quincy Canal and Pipe at Head (diversion at Rex)	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.5

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 894-007	
Filename: Deer-Creek-2000.dwg	TUNNEL / CHINA UNION CANAL FLOW SCHEMATIC
Drawn By: JAQ	Kleinschmidt — Energy & Water Resource Consultants — 351 South Auburn Street, Suite C, Grass Valley, California 95945, Telephone: (530) 477-8808, Fax: (530) 477-8885, www.KleinschmidtUSA.com
Date Revised: 08-17-09	D6

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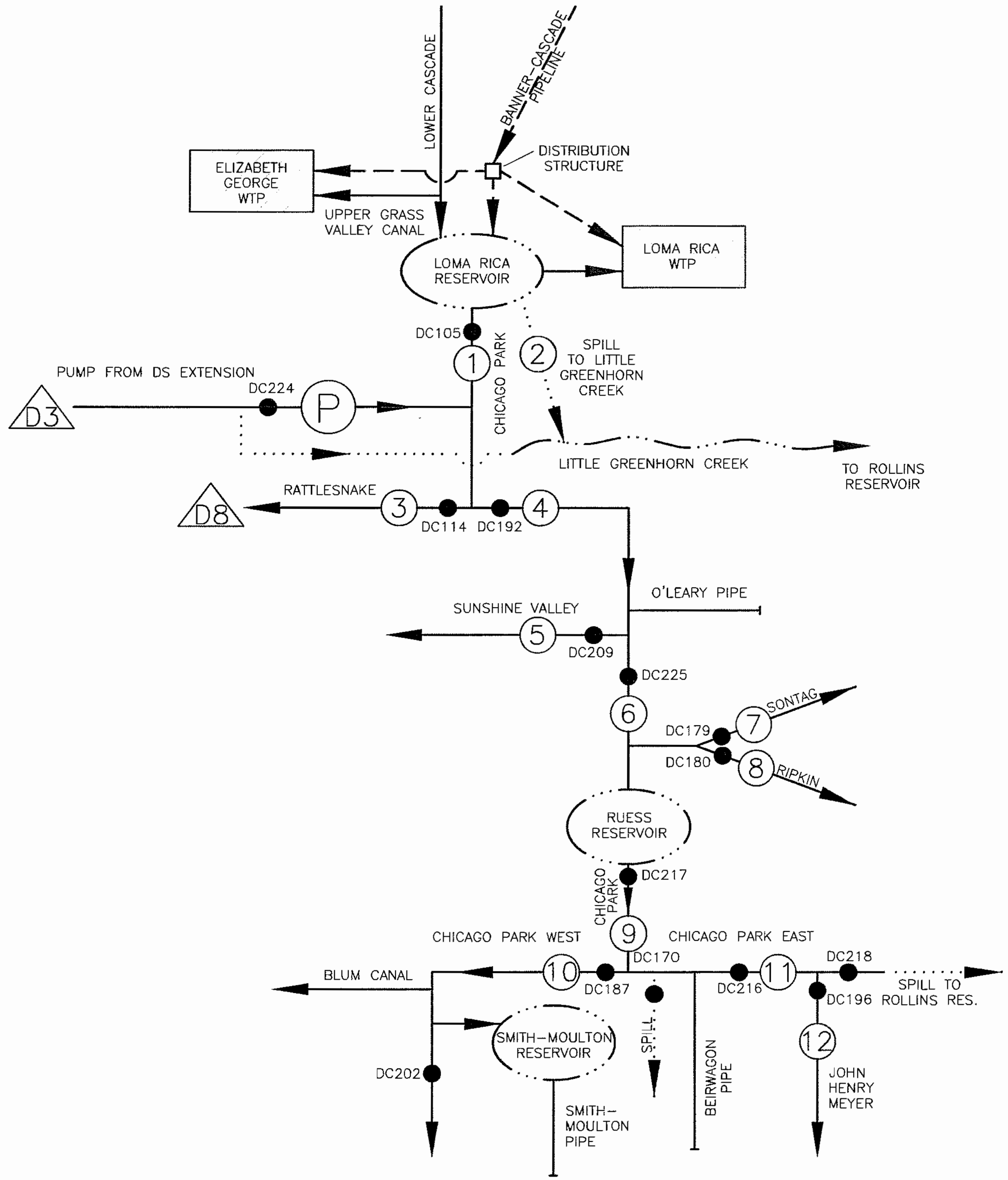

Index		Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
(1)	Chicago Park at Head (DC105)	30.5	30.9	35.3	40.9	44.1	47.1	49.6	52.3
(2)	Little Greenhorn Creek	1.2	1.3	1.5	1.9	2.0	2.2	2.4	2.6
(3)	Rattlesnake Canal at Head (DC114)	12.1	12.6	15.4	19.3	20.9	22.1	23.0	24.0
(4)	Chicago Park d/s of DC192	12.9	12.9	13.9	15.0	16.1	17.3	18.2	19.2
(5)	Sunshine Valley at Head (DC209)	2.5	2.3	2.5	2.7	2.9	3.1	3.4	3.7
(6)	Chicago Park d/s of DC225	9.3	9.7	10.5	11.3	12.1	13.0	13.6	14.2
(7)	Sontag Canal at Head	1.7	1.7	1.9	2.0	2.2	2.4	2.4	2.4
(8)	Ripkin Canal (DC180)	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(9)	Chicago Park d/s of DC217	7.0	7.2	7.8	8.4	9.0	9.7	10.2	10.7
(10)	Chicago Park West at Head (DC187)	2.8	2.9	3.2	3.4	3.6	3.9	4.2	4.5
(11)	Chicago Park East d/s of DC216	2.1	2.1	2.3	2.5	2.7	2.9	3.1	3.4
(12)	John Henry Meyer (DC196)	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

Scale: NTS
Project No: 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 08-17-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

CHICAGO PARK CANAL FLOW SCHEMATIC

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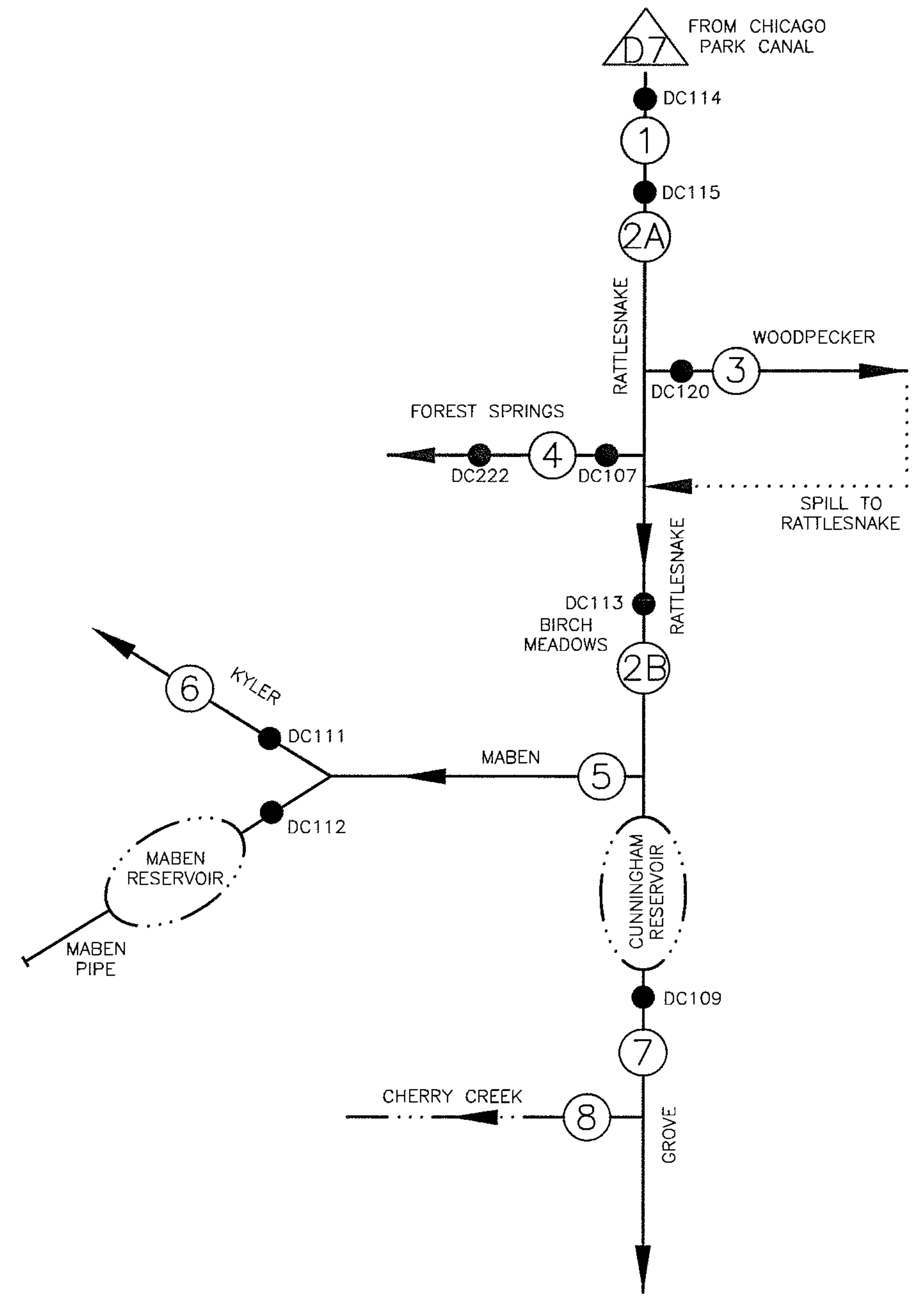

	Index	Estimated Peak Flow (cfs)							
		2007	2008	2012	2016	2020	2024	2028	2032
1	Rattlesnake Canal at Head (DC114)	12.1	12.6	15.4	19.3	20.9	22.1	23.0	24.0
2a	Rattlesnake d/s of DC115 (above Woodpecker)	11.2	11.7	14.3	18.1	19.6	20.8	21.7	22.6
2b	Rattlesnake d/s of DC113 (at Birch Meadows)	8.8	9.8	12.4	16.3	17.6	18.6	19.6	20.6
3	Woodpecker at Head (DC120)	1.1	0.9	1.0	1.1	1.2	1.3	1.3	1.3
4	Forest Springs at Head (DC107)	1.6	1.5	1.7	1.8	1.9	2.1	2.1	2.1
5	Maben at Head	3.2	3.3	3.6	3.9	4.2	4.4	4.6	4.8
6	Kyler (DC111)	1.4	1.4	1.5	1.7	1.8	2.0	2.1	2.3
7	Grove at Head (DC109)	3.1	4.5	7.3	11.6	12.5	13.5	14.5	15.7
8	Cherry Creek	0.5	0.6	0.7	0.8	0.8	0.8	0.8	0.8

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

Scale: NTS	RAW WATER MASTER PLAN UPDATE WATER DEMAND ANALYSIS
Project No: 894-007	
Filename: Deer-Creek-2000.dwg	RATTLESNAKE CANAL FLOW SCHEMATIC
Drawn By: JAQ	Kleinschmidt — Energy & Water Resource Consultants — 251 South Auburn Street, Suite C, Grass Valley, California 95945, Telephone: (530) 477-8808, Fax: (530) 477-8885, www.KleinschmidtUSA.com
Date Revised: 08-17-09	D8

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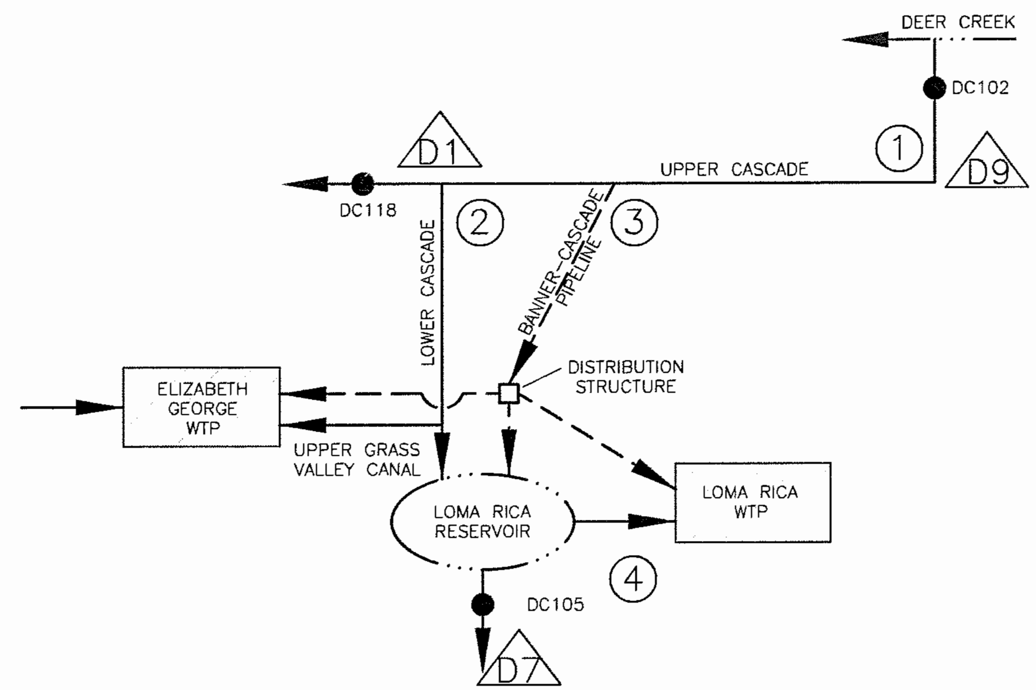

Index	Estimated Peak Flow (cfs)							
	2007	2008	2012	2016	2020	2024	2028	2032
(1) Cascade Canal at Head (DC102)	50.6	54.3	61.9	70.5	76.1	80.7	83.4	86.3
(2) Cascade Canal (u/s of Upper Grass Valley Canal)	5.1	7.7	7.9	8.0	8.2	8.4	8.5	8.7
(3) Banner/Cascade Pipeline (under development)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Chicago Park at Head (DC105)	30.5	30.9	35.3	40.9	44.1	47.1	49.6	52.3

NOTE 1: FUTURE FLOW VALUES THAT DO NOT INCREASE INDICATE THAT CANAL SEGMENT HAS REACHED ASSUMED SATURATION LIMIT

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Scale: NTS
Project No. 894-007
Filename: Deer-Creek-2000.dwg
Drawn By: JAQ
Date Revised: 11-05-09

RAW WATER MASTER PLAN UPDATE
WATER DEMAND ANALYSIS

CASCADE CANAL FLOW SCHEMATIC

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